ACCIDENT INVOLVEMENT AND EXPOSURE TO RISK FOR CHILDREN AS PEDESTRIANS ON URBAN ROADS

by

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ABSTRACT

A detailed literature review reveals the need for further study of several aspects of road accidents to child pedestrians in urban areas. Some of these aspects are explored using data for selected residential parts of five urban areas in Britain.

Road accidents in the five study areas are examined using Local Authority accident data, police accident reports, local knowledge, and data from the 1981 census of population. Variations in occurrence of these accidents are analysed using variables such as age and sex of the child, type of location, distance from home, severity, and time of occurrence.

Collection and analysis of data concerning exposure on journeys to and from school and during some other uses of the roads are described. Data on journeys to or from school was collected by questionnaire from most of the schools in each of the study areas. Analysis examines several features of exposure including mode of travel, accompaniment, time spent outside, distance travelled, and the number of roads crossed. These features are analysed for different groups of people, at different times, and in different sorts of area. Where possible results are related to accidents to produce measures of risk.

Data on journeys other than those to and from school, with particular emphasis on play, was collected in two of the study areas by direct observation of children on the streets. These observations

were carried out to a preset schedule, using routes predefined on the basis of accident and other local information. Analysis examines the variety of children using the roads in different areas and time periods. Where possible, accident data and traffic flow information are related to the results to produce measures of accident risk.

Suggestions for preventative measures, and for additional research, both within these study areas and more widely, are given.

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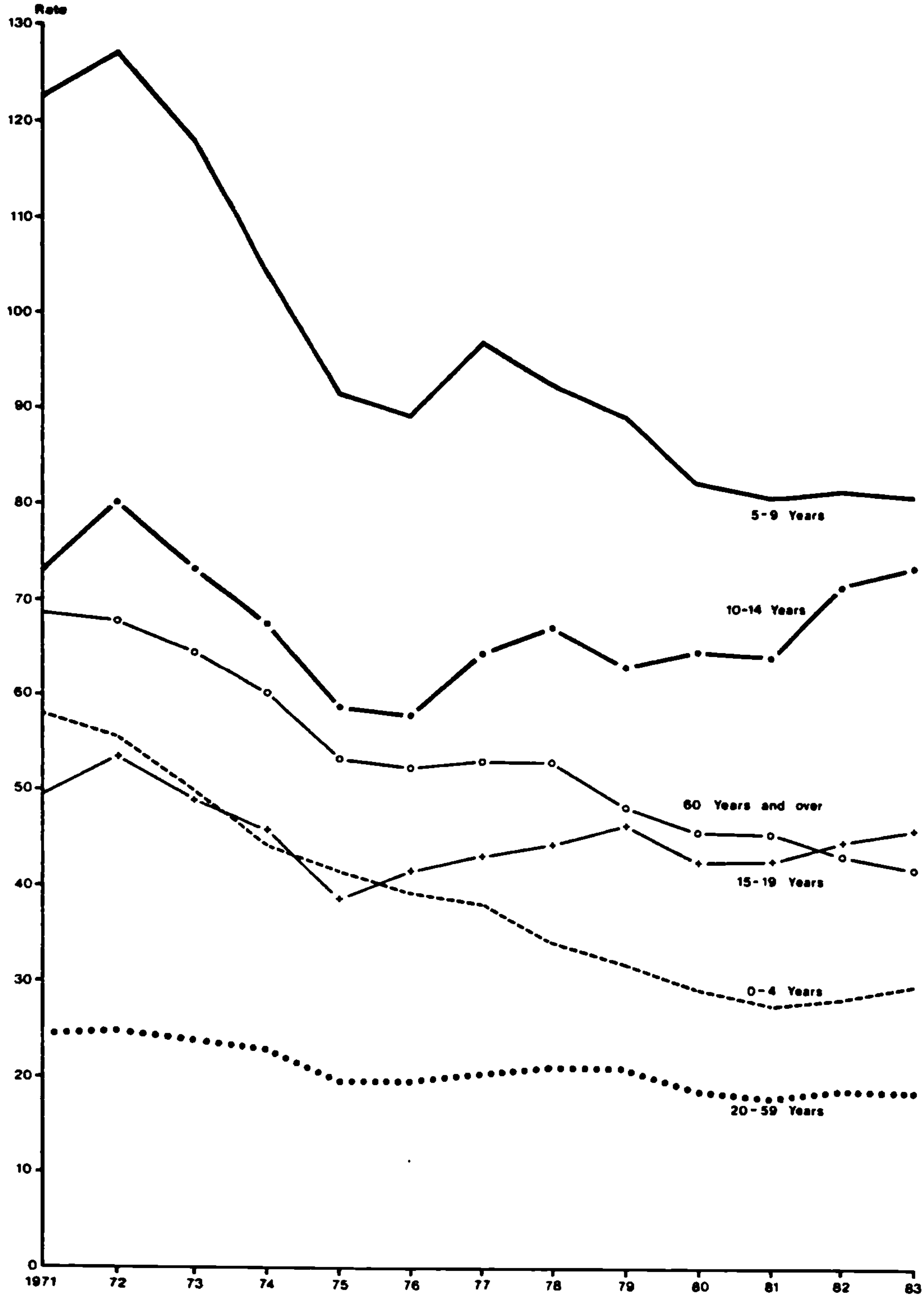
CHAPTER 1

INTRODUCTION

Road accidents to children have been a serious problem for many years. "Accidents in road traffic are the leading single cause of death of children in highly motorised countries" (OECD,1983,p.9). Child pedestrians particularly, are involved in more accidents than their proportion of the population would suggest. National statistics for Great Britain (see Figure 1.1) indicate that, between 1972 and 1983, child pedestrians in the age groups 5 to 9 years and 10 to 14 years experienced a higher rate of death and injury in road accidents per head of population than other age groups, and that even though this rate has got less over these years for the 5-9 year age group, they still have about four times as high a rate as adults aged between 20 and 59 years (Department of Transport (DTp),1984). The rate of accidents to child pedestrians aged 5-9 years has, since 1977, been dropping, while over the same years, the trend in the rate of accidents to child pedestrians in the age group 10-14 years has been upwards. If these trends continue, then soon the number of accidents per head of population to children aged 5-9 years will be overtaken by that of the 10-14 year age group. To put the rates of accidents shown in Figure 1.1 in some perspective, in 1983 at least 25674 children aged 0 to 15 were injured on built up roads. Of these 396 were killed and a further 6771 seriously injured (DTp.,1984).

Figure 1.1

Pedestrians killed or seriously injured per 100,000 population: 1972–1983



Source: DTp.,1984.

It has been shown that most accidents to child pedestrians happen in residential areas (Faulkner,1975). This thesis will be concerned with road accidents to child pedestrians in 5 such study areas, and will seek to describe some of the characteristics of these, and then to carry out further research on the exposure and behaviour patterns of children so that some of the main factors contributing to these accidents can be identified or clarified. It is thought, despite the small extent of the study, that some of the results produced here will be applicable on a wider scale, and more importantly that the methods used will also be applicable to stuaies in other areas.

1.1 Background to the study

This study is linked to a larger ongoing project, the TRRL Urban Safety Project, which is examining the effectiveness of low cost, area wide techniques aimed at reducing accidents to all road users. Five study areas used in the Urban Safety Project are also used in the present study. The link to this project has meant that there has been easy access to some of the accident data relevant to the study areas, and also that contacts within the Local Authorities involved, who played an essential part in the development of the work, were approachable from the background of this larger study, rather than from the potentially less successful point of view of an isolated piece of research work for a higher degree.

1.2 Outline of the thesis

The first part of this study (Chapter 2) consists of a detailed review of available literature on all aspects of road accidents to child pedestrians. This provided the basis for deciding which areas of study most warranted further attention. As a result of this the following layout or plan for the thesis was devised. Chapter 3 consists of a background description of the study areas and an analysis of the patterns of road accidents to child pedestrians within them over the six year period 1979-1984. This utilizes Local Authority accident data, more detailed police accident records, and data from the 1981 Census of Population. Comparisons are made where possible with the results of other similar studies and with national statistics. Chapters 4, 5, and 7 describe two methods which were used to obtain data on children's exposure to risk on the roads in the study areas, first on the journeys to and from school, and then on other journeys, with particular reference to play. The exposure data was analysed first in its own right and then, where comparable, in relation to some of the results found in Chapter 3 to provide measures of accident risk or relative risk for certain groups of children, at certain times, on particular journeys, and in particular locations in the study areas. The results of these analyses for the two types of exposure survey are given in Chapters 6 and 8. An overall summary of the results, and the conclusions reached are given in Chapter 9. Finally Chapter 10 discusses some further analyses which could be carried out using the existing data sets, and also ways in which the study could be extended if the time and money were available.

CHAPTER 2

A REVIEW OF RECENT AND CURRENT RESEARCH ON THE CAUSES AND NATURE OF ROAD ACCIDENTS TO CHILD PEDESTRIANS

This review is split into 5 main sections which it is thought reflect the nature of current research on child pedestrian road accidents. The first 3 of these examine methods of data collection, analysis and some of the results that these have produced. Section 2.1 examines road accident data, Section 2.2 exposure data, and Section 2.3 data regarding children's behaviour in the road environment. Traditionally these are the three sets of data that have been collected in the search for the causes of accidents. Sections 2.4 and 2.5 examine the use of different types of preventative measures, with particular reference to those aimed at child pedestrians.

Reference will be made to the findings of the many studies reviewed here throughout the remainder of this thesis.

2.1 Statistical analyses of road accident data

2.1.1 Data limitations. Statistical analyses of road accident data form a basis for all research on the causes of road accidents. In order to be able to make use of behaviour or exposure measures, it is necessary to have some knowledge of the accident situation. Despite this, it is a mistake to place too much reliance on explanations of accident causality based upon analyses of road accident statistics alone. These statistics can often be misinterpreted due to a lack of supplementary data, in particular exposure data.

Accident statistics in Britain are usually collected by the police, who fill in a form known as 'Stats 19' for every injury accident they attend, or have reported to them. Some care should be taken when analysing this data, as the police are not always called to injury accidents, and thus, the validity or completeness of this data is open to question. It has been shown by comparing hospital records on road accident victim admissions with Stats 19 data, that about one sixth of serious injuries and one third of slight injuries caused by road accidents do not appear in police notifications (Bull and Roberts,1973). Other attempts have been made to match hospital data with Stats 19 to supplement the injury information given by the latter. Due to the anonymity of both Stats 19 and computerised hospital records this is difficult to do, and it is estimated that only about 50% of hospital records can be readily matched (Nicholl,1980). The probability of enabling data to be matched while preserving the confidentiality of medical records is being examined by the relevant authorities.

Problems will also be encountered if any attempt is made to compare accident patterns in this country with those from elsewhere in the world (OECD,1983). Two particular problems have been identified. These are firstly that "methods of data collection differ significantly from country to country and the definitions used for certain accident terms are often at variance. Recording of the data is also different: death within 24 hours, 3 days, 6 days or 30 days following the accident may be recorded as a road fatality". Secondly that "methods of analysis are equally at variance. Thus some countries analyse data according to differing age groups (0-6 years....)". This OECD study examined data from what were essentially 'more developed' countries. Road accident data collected in the 'less developed' countries is likely to be even less standardized (Jacobs and Sayer,1983).

In spite of these problems, accident analyses are still worthwhile, and some have proved to be very useful. Most have concentrated on simple breakdowns of 'Stats 19' data. Results from these are well known, and will not be considered in detail here. The types of breakdowns which can be carried out using 'Stats 19' data are numerous, as a large number of variables are collected. These include the time of the accident, its location, background information about the people involved, and an English language description of the accident. Several literature reviews of studies concerned with pedestrian accidents to children already exist. See for instance Van der Molen (1981), OECD (1978 and 1983), Wade et al (1982), or Heraty (1986).

2.1.2 <u>Results of accident analyses using 'Stats 19' data alone.</u>

In general terms most studies of child pedestrian accidents have shown the following. The majority of accidents to child pedestrians (97%) happen in built up areas (DTp.,1983b) and within these, in residential areas (Faulkner,1975). In terms of time the biggest proportion of accidents occur between 3 and 6pm (for instance see Grayson,1975a, Tight,1984, Jonah and Engel,1983, Wade et al,1982, or Okamoto,1978). Most studies have shown that between 9 and 33% of accidents occur on the journeys to or from school (Grayson,1975a). Most of the accidents involve a single car (Grayson,1975a or Tight,1984). Children aged between 5 and 9 years had a greater number of pedestrian accidents per year than other younger or older children, with about twice as many of these to boys as to girls (Howarth et al,1974, Grayson,1975a or Tight,1984). Child pedestrian accidents involving children under 10 years occur predominantly on minor roads, in residential areas (Grayson,1975a, Preston,1972 or Tight,1984). More accidents to older children occur on major roads. Several studies have found that 'dart out' accidents are the most common type amongst young children (e.g. Jonah and Engel,1983 or Sandels,1975). The great majority of accident records imply that the child was the cause of the accident (see Jonah and Engel,1983 or Tight,1984).

2.1.3 <u>Accident analyses using other sources of data</u>. 'Stats 19' data alone do not always provide enough information on child pedestrian accidents to allow the desired analyses to be carried out. Because of this, some studies have attempted to increase the amount of data collected by using other sources of information. Generally this either involves asking the attending police officers to record more than their normal quota of information, or contacting the children involved, after the accident.

Perhaps the most notable example of the first situation, is work that was carried out in coordination with the Hampshire Constabulary in 1972 (Grayson,1975a). The intention of this was to record some additional variables such as journey purpose, distance from home, accompaniment, and the child's view of the cause of the accident. Results showed that most children were injured within a quarter of a mile of their home, though this does vary with age, with more older children being knocked down further from home (see also Tight,1984). Very few were not familiar with the street in which the accident occurred. More than one third of the pre school children were playing in the street when knocked down. Many more boys were playing in the streets than girls at the time of the accident and less than half of the children said they were alone. Only 40% said that they had stopped at the kerb, while as many as 80% were reported to have been running across the road. In most of the accidents the child stated that they had not concentrated on crossing when they had their accident. Because of this very few of the accidents could be attributed to misjudgement by the child of the crossing situation, such as wrongly estimating the speed of an approaching vehicle.

A study in Birmingham looking particularly at accidents on the journeys to and from school (Driscoll and Ashton,1981) used 'Stats 19' information and supplemented this with further information from statements made by involved parties and witnesses. It was found that 29% of accidents to child pedestrians (<15 years) in one year were on a journey to or from school. One third of these were within 250m of the child's school, and a further 11% were right outside the school. Results showed that 33% of the school journey accidents were in the morning, 21% at lunchtime, and 47% in the afternoon. It was also found that casualties on the journeys to and from school tended to be less serious that those on other sorts of journeys. They conclude that the main causal factors in accidents outside or near to schools appear to be firstly the child dashing out into the road without looking, and secondly masking of children by stationary vehicles. It was pointed out that accidents outside schools would appear to be particularly amenable to the implementation of remedial measures as they occur at specific times and locations, and seem to result from specific actions.

Another important study of accidents was carried out in Sweden (Skandia,1971). This considered the problem on two levels. First, by the usual breakdowns of the accident statistics. Second, by a very detailed inspection of all the available witnesses descriptions of each accident. The aim was to try to identify the reasons behind each, and to see if there were any common factors which could be used as a basis for identifying methods of reducing the accident toll. It should be borne in mind that in Sweden, the method of reporting accident statistics, although different from that in Britain, still leads to problems of interpretation. The police must submit their accident information to the Central Bureau of Statistics within 48 hours of an accident. It is suggested that this often means that the information is largely based on the statements of drivers, and thus biased towards their opinions of what happened. The conclusion of these studies, which was arrived at in a later report, was that "it is impossible to adapt fully small children [under ten years] to the traffic environment. They are biologically incapable of managing its many demands" (Sandels,1975,p.147). It was suggested that because the traffic system was built by adults, for adults, children cannot come to terms with it. These conclusions, if correct, have far reaching social and planning implications in terms of the present day structure of society. However, others have argued that Sandels' conclusions are perhaps too far reaching, as it seems that some young children are able to come to terms with present day levels of traffic quite adequately (Howarth et al,1974).

A study in Denmark (Wallin,1979) extracted the names of 124 children injured in road accidents, either as pedestrians or as cyclists, from the records of Odense University Hospital. The children were subsequently located, and further information about the accidents was gained. The sample size was unfortunately by necessity small due to the amount of time and effort involved in finding and interviewing each child. Important facts such as the level of supervision and instruction of the children were added to the accident data set. It was found that few children were accompanied by adults, even when they were as young as four years old. Other studies have shown that children as young as 2 years are allowed to use the streets alone (Sadler,1972). Reasons given in the Danish study for the lack of supervision were that the child was considered to be familiar with the traffic environment in that area, and thus capable of crossing the roads. 55% of the child pedestrians had received permission to go alone in traffic from age 5 years. 14% of the children had never been accompanied to school, while a further 31% had only ever been accompanied on their first day.

2.1.4 <u>Studies of the background of children involved in accidents.</u>

There have been a set of studies, mostly some years ago, which attempted to look in more detail at the home and social background of children who have been involved in road accidents, with the aim of deriving a relationship between different types of background and road accident involvement. These studies have used two main techniques for obtaining this sort of information about children. The first of these is by directly asking either the children or their parents; the second, a more indirect method, involves examination of census information.

One such study carried out in the United States (Manheimer and Mellinger,1967), selected from a large sample of children aged 4 to 18, those who had previously been involved in an accident (though this was not necessarily a road accident). On the basis of an accident score, the children were then split up into groups of "high", "intermediate" and "low" liability. It was discovered that there was a "statistically significant relation between accident liability and indexes of extraversion, daring, roughhousing, and other traits tending to expose children to hazards. Similar relations held for traits such as poor discipline, aggressiveness towards peers, and, for girls, attention seeking" (Manheimer and Mellinger,1967,p.491). It is possible that these characteristics may partly be to blame for some road accidents to child pedestrians.

A second such study looked in detail at families where a healthy child had survived a road accident (Backett and Johnston,1959). Results suggested that the vulnerability of these children to accidents is associated with one of the following characteristics. Firstly illness, either maternal or elsewhere in the household;

secondly maternal preoccupation, for instance with outside work, other children, or pregnancy; thirdly crowding in the home, lack of protection during play, and lack of elementary play facilities.

A more recent study examined the background of children involved in road accidents by means of a questionnaire (Bocher,1978). Certain family and home characteristics are found to be more common in children who have been involved in an accident. They come more often from families in a lower social status group, containing a higher than normal number of children, and having a father with a greater than usual amount of responsibility in the household. Children who had been involved in a road accident were found not to attend kindergarten so frequently as children who had not been involved in a road accident. Their fathers have a lower level of car ownership than normal. The children have less spacious living accomodation, and are often situated in an urban area with a higher traffic density. The study also identifies types of traffic environments which appear to be linked with a high probability of accidents involving children. These have a high density of traffic; a relatively high speed of cars; too many kinds of traffic; crossroads with many cars turning into another road; a high frequency of pedestrians; a medium frequency of children; broader streets; residential roads which are used by through traffic; streets in which house entrances open directly onto the street.

A study using variables from the 1966 Parliamentary Sample Census to examine the background of children involved in road accidents in Manchester and Salford was carried out (Preston,1972). Results showed that the injury rate of child pedestrians aged 3-7 years per 1000 children is much higher in some areas of Manchester and Salford than others, and that the injury rate correlates with "(a) the distance of the area from the town centre; (b) an index of overcrowding for the area;and (c) an index of social class for the area" (Preston,1972,p.332). Boys were found more likely to be injured while playing than girls. It was concluded that lack of safe play spaces may be the main difference between the areas where the accident rate is high and the safer areas. Further work on this particular aspect of research, utilizing more up to date census information may well be rewarding.

Finally, research carried out at King's College Hospital, London (Lintell,1979) attempted to show whether a relationship existed "between certain intellectual, social and personality factors and child pedestrian road accidents". It was found that, "the child pedestrian, aged five to ten years, most at risk is likely to be a member of a large family and to come from the less affluent groups in our society. The child is likely to live in a house, as opposed to a block of flats and to be able to play in a garden rather than a communal playspace, such as that provided by flats". It was also shown "that the child is likely to be aggressive and to lapse into instability under stress, but he or she is also expected to be independent and shoulder responsibility for which he or she is not yet ready" (Lintell,1979,p.5).

2.1.5 Conclusion. The studies above provide a useful starting point from which to look at accident causality. In order to improve the picture they provide it is necessary to combine this with results from corresponding studies looking at the exposure of children to risk, and at the behaviour of children in the road environment. It is only upon this sort of background that attempts at accident prevention can be soundly based. The following two sections will examine research which has been done to date concerning firstly exposure to risk, and secondly children's behaviour.

2.2 Exposure to risk

In the literature to date, one of the problems of the concept of exposure to risk would seem to be that of definition, or rather too many definitions. However, the following three quotes build up an accurate picture of the true meaning of exposure. For the individual exposure is "being in a situation which has some risk of involvement in a road traffic accident, a risk which theoretically can be measured for both active and passive elements of the traffic system" (Wolfe,1982,p.337). In more general terms it is "the frequency of a particular occurrence with reference to participation in traffic" (Van der Molen,1981,p.195), or "it is a concept by which the researcher tries to take account of the amount of opportunities for accidents" (Chapman,1973).

The need for further information to supplement accident studies is now well known and generally accepted. "For accident data to be useful they should be compared with the experience of the non-accident population, or the population at risk" (Knoblauch et al,1984). This is because "empirical data on children's exposure, accidents and behaviour are a necessary prerequisite for the selection of the most important educational objectives" (Van der Molen,1981). Several situations have been identified where traditional road safety teaching, to date based largely on accident studies alone, could be improved if various sorts of exposure studies were undertaken

(Grayson,1981). In at least one of these situations new research (Howarth and Repetto-Wright,1978), indicates that for some age groups of children, the training methods/objectives should be changed. Similarly, Brog and Kuffner (1981) have shown that the number of accidents alone does not give a complete and accurate picture of accident risk.

To date there have been no regular studies of the exposure to risk of child pedestrians (or of all pedestrians). Research has mostly either been carried out as an 'extra' to some other study, or as a one off piece of research designed to identify specific facets of exposure, or to test a method of data collection. Few literature reviews of this work exist, perhaps the most extensive and up to date ones being Van der Molen (1981), OECD (1983), Elliot (1985), or Heraty (1986).

There are a variety of methods that have been used to collect exposure data. The OECD (1983) define four. These are the interview (either personal or telephone), the questionnaire, observation, or automatic recording devices (e.g. video cameras). Essentially these can be considered as two groups, the actual observation of events as they happen, and the extraction of information after the event from the people involved. It is possible to collect data using these methods either continuously, periodically, or with regard to certain events that may occur, such as the installation of a new traffic safety scheme.

In a series of studies in Nottingham, four methods of exposure data collection were tested (Howarth et al,1974, Routledge et al,1974a and b, and Routledge et al,1976). These were: interviews with children; interviews with their parents; the direct observation of a sample of children's journeys, either by film or by following them; and finally by observation at a series of randomly chosen sites. On the basis of the results the advantages and limitations of each were assessed. The principal findings were as follows. The interview survey would have been ideal, except that the time and manpower did not exist to involve a sufficient number of children. This would also be the case if parents were interviewed. It was found in the study that parents tend to underestimate children's exposure. The third method would provide an objective account of journeys, but is even more severely limited in terms of the number of children that can be involved. As well as more obvious disadvantages, following children can only really successfully be carried out on the way home from school in the afternoon. The fourth method implies some prior knowledge of the routes that children are using, and also means, as in all observation studies, that the age and indeed the sex of the child have to be estimated. Experience has shown that these cannot always be done accurately, though practice in identifying children of different ages could probably reduce this problem to a minimum. This method would also mean that only a limited number of sites could be surveyed.

These criticisms of the methods used by Routledge et al, point towards a need for new ways of obtaining exposure both by interview and by observation. A method is needed which could provide the numbers of interviews required for statistical analysis, but in a cheap and efficient manner. Also required is some method which would combine the merits of following children and stationary observation, whilst at the same time removing the disadvantages of each.

Adaptations of the 'Routledge' methods which have progressed towards these ideals will be discussed in more detail below.

One of the problems of exposure work is which measure of exposure to use, or which is the most useful and reliable in terms of the results desired. Some of the many measures available are highlighted by Todd and Walker (1980) in a survey designed to "ascertain how much adults go about on foot" (see also the discussion on Jonah and Engel,1983 below). These are the mean number of pedestrian casualties:

1. per day per 100,000 population;
2. per day per 100,000 people in the population who go about on foot;
3. per day per 100,000 people in the population who do some walking in an average day;
4. per 100 million kilometres walked;
5. per 100 million hours spent walking;
6. per 100 million roads crossed;
7. per 100 million interviewer crossing paces (the number of paces taken by the interviewer to cross the road when he/she retraced the walking routes).

Some of these will obviously be more relevant to particular circumstances, and obviously account should be taken of this before choice of a measure to use is made. It is also clear that the total list of exposure measures would be much longer than this, as many different variations on the above are possible. Most studies of exposure up to now have concentrated on one or two of the available measures. Ideally as many as possible should be included in each survey so that over time some idea of the most useful ones can be built up. It is also important to realise that it is possible, even quite likely, that different information will be obtained from different measures, and so the more that are measured, and the more carefully they are chosen with regard to the aims of the study, the better.

Current research on exposure seems to fall readily into one of two categories. These are either interview or observation studies. The next two sections will consider some of the principal studies in each of these categories in turn.

2.2.1 Interview studies. These studies have largely been done with the aim of looking at children's exposure on various types of journey. This section examines three types, namely those specific to play journeys, those specific to the journeys to or from school, and others.

Children's use of the streets for play

Two studies will be examined in this section, both of which give some general ideas of children's use of the road system for play purposes.

The first of these is one of the most thorough and nationally representative surveys in this field carried out to date, although it is not specifically aimed at defining children's exposure to risk (Sadler,1972). Mothers of children between 2 and 8 years were questioned about the form and quantity of their children's play.

Results showed that between a third and a half of children are said by their mothers to include the street among their usual play places, although this does vary with age. A study in Stuttgart, Germany found that 20% of children on average play in the streets, and that this figure increases with age (Limbourg and Gerber,1981). The British study showed that children living on estates were most likely to play in the street, while those who lived in houses with gardens, and those living in rural areas were less likely to do so. This study did not actually relate the incidence of playing in the street to the occurrence of road accidents, but it is interesting to note that mothers who said they worried about their children's potential involvement in an accident, and those who had experience of accidents, did not keep them from playing in the street more than other mothers.

The second questionnaire study took place in Nottingham (Newson and Newson,1976). Parents of 7 year old children were asked about their children's play habits. Results showed that boys were more likely to play in the streets than girls. The study presented a picture of the seven year old being a "territorial animal whose terrain is limited not so much by physical boundaries as by familiarity and habit, backed up by certain fairly explicit rules laid down by his mother and designed to promote a healthy fear of the dangers he may meet if he strays too far" (Newson and Newson,1976,p.94). If children venture outside these boundaries then special precautions are usually necessary. Definite geographic boundaries had been laid down by 62% of mothers who were questioned. Their results show that "by the age of 7, and in a whole variety of ways, the daily experience of little boys in terms of where they are allowed to go, how they spend their time and to what extent they are kept under adult surveillance is already markedly different from that of little girls" (Newson and Newson,1976,p.108).

These studies give a general picture of the type of use that children make of the streets for play and the limits to which their parents are prepared to let them go. However, neither in fact aims to define exposure levels, nor do they attempt to relate their findings to either local or national accident statistics.

The journeys to and from school

Unlike the play surveys examined above, interview surveys concerning the journeys to and from school range, in terms of exposure, from more general studies looking at mode of travel, to more detailed studies of catchment area size, distance travelled, time taken, and so on. This is possibly because journeys to and from school are, due to their repetitive nature, more suited to questionnaire type surveys than are play-generated journeys.

Rigby (1979) carried out a literature review of research on children's school journey characteristics, in particular looking at the mode of travel and distance travelled. He identifies large differences in journeys to primary schools compared with journeys to secondary schools. The former are usually short with four fifths made on foot. Levels of accompaniment vary largely from school to school, though in general accompaniment by adults is higher than it is to secondary schools. Walking is more common in the afternoon than in the morning, while car usage is correspondingly higher in the morning than in the evening. No other mode shows appreciably different levels of usage between the morning and evening. In secondary schools, although walking is still the single most important mode, motorised transport modes together outweigh it. A questionnaire survey of mothers of children aged 5-8 years in England, Wales, and Scotland showed that only about 20% of primary school children walk for more than 15 minutes on the way to school, and about 25% on the way home (Sadler,1972). Secondary school children from a sample of schools in Berkshire and Surrey took on average 23 minutes travelling to school in the morning and 29 minutes travelling home in the evening (Rigby and Hyde,1977). Another study (Hillman and Whalley,1979) showed, using data from the 1975/1976 National Travel Survey, that 84% of walk journeys to and from primary schools were less than one mile, and 50% were less than half a mile, while for walk journeys to and from secondary schools only 33% were less than half a mile, and over 33% were greater than one mile long.

A study in Stuttgart (Limbourg and Gerber,1981) interviewed 846 parents about their children's traffic participation. Results showed that as they grew older children were accompanied less and less on the journeys to and from school by adults; 97.5% of 3 year olds were accompanied, 87.5% of 4 year olds, 79.3% of 5 year olds, 42.3% of 6 year olds, and less than 10% of 7 year olds.

Bell and Tether (1983) found in a London borough that between secondary schools there were widely differing characteristics of modal choice from school to school. Walking was the main mode for mixed council schools, but not for single sex council schools, independent schools or a tertiary college. Two things probably explain this. Firstly the relative size of the catchment areas of the schools, and secondly the relative affluence of the households from which the children come. Mensink (1973) looked at the first of these points in a study in Milton Keynes. Results showed that at short distances from schools, walking accounts for almost 100% of the journeys, while the peak share for cycling is 37% at 2.0km, for cars it is 48% at 2.3km and for the bus it is almost 100% at 5.5km and above. He also found that car and bus usage varies with family car ownership, though no such change is noted in walking and cycling.

Reiss (1977) examined children's attitudes to the journeys to and from school by means of a questionnaire. Differences in the attitudes of males and females towards certain aspects of these journeys were identified. Males showed they were more willing to go to school alone, and tended to take the shortest route, while females tended to choose their routes because they were taken by parents, or because they would be willing to go a different route if told to do so by their parents. Older students were more often found to walk, to go alone, to take the shortest route, and to take a different route only if friends did. Younger children were more often taken to school by bus or car, were taken by parents, took a route that avoids traffic and took a different route to school if told to do so by parents or school officials.

Grimshaw and Mathew (1985a to e) questioned 3464 children in secondary schools in a selection of London boroughs about their journeys to and from school. They found that a larger proportion of boys than girls walked (51% compared to 41%) and cycled (11% compared to 6%), while a larger proportion of girls than boys travelled by bus (39% compared to 26%). Three measures of accident risk to children were worked out for the Greater London Council area as a whole based upon their sample survey. These showed that on journeys to and from school there were 181 casualties per 100,000 population to child pedestrians aged 10 to 15 years, 11 casualties per million journeys, and 31 casualties per million hours in the road environment. No more detailed breakdowns of these figures were given.

Other studies

Three studies aimed at obtaining more specific exposure data, and relating the findings to accident data, to provide measures of relative risk, were carried out in Britain by Goodwin and Hutchinson (1977), in Germany by Brog and Kuffner (1981), and in Canada by Jonah and Engel (1983). None of these was specific to a particular journey type, but rather sought to examine all journeys made by respondents over a period of time.

The first of these used data from the British National Travel Survey, in which respondents were asked to record in diaries all the trips they made in a week. Analysis of the walking done by 17000 individuals showed that the average person walked for 20 minutes and 1.3km per day. Their results gave an overall pedestrian accident rate of about 500 accidents per 160 million kilometres walked (i.e. one accident per 320,000km walked). Accident rates were shown to be higher for young and elderly pedestrians, and among children boys had higher rates than girls.

Similar results were found in the second study, which used a random sample of people over 10 years of age in the Federal Republic of Germany. In a written survey, all out-of-home activities of 54000 persons were recorded for 107000 random sampling days throughout a year. It was found that pedestrians aged 10-14 years and over 64 years had the highest accident rates per head of population, per number of trips, per unit distance travelled and per unit time spent travelling, and that these rates were also higher for males than for females.

The third study, in Canada, attempted to develop a methodology by which accident and exposure data could be measured separately, and then combined together to provide a measure of risk. The study used data from a medium sized community in Ontario (500,000 population). Half of the respondents were questioned by telephone, and half by face to face interview. Several measures of exposure were used in the analysis. These were the number of inhabitants of particular age or sex in the area, the number of trips made, the number of kilometres walked, the duration of the journeys, and the number of road crossings made. They found that when distance travelled, duration of journey, and number of streets crossed were used as measures of exposure, children and elderly people had the highest levels of risk. The study did not look at exposure at a more local level, or suggest methods of reducing the numbers of accidents.

The main limitation of these three studies in the context of the present study is that they were not specifically aimed at examining child pedestrian exposure, and therefore could not really cover it in sufficient depth to provide a basis for the design and evaluation of preventative measures on a local scale.

2.2.2 Observation studies. On the whole these have been more specifically aimed at defining levels of children's exposure than the interview studies above. This is to be expected as once out in the field, the opportunity generally presents itself to record highly detailed aspects of exposure and behaviour, which do not rely so much upon the recall ability and accuracy of an interviewee.

Once again these studies will be considered under the three headings of those specific to play, those concerning the journey to or from school, and other studies.

Children's use of the streets for play

In a study in Sweden, the playing habits and playing areas of young children were observed (Sandels,1975). Results showed that the amount of time spent outside increased with age, and interestingly that children from multi storey flats spent more time outside than children from 'low houses'. By identifying 'suitable' and 'unsuitable' play places it was found that older children spent greater amounts of time in unsuitable places than younger children. Unlike in some of the studies discussed above, no sex differences were found in this study. It was discovered that girls were indoors more in the mornings and outside more in the afternoons, while boys showed a more even distribution of time outside over the whole day. Finally, most children (82.5%) were observed less than 100m from the door of the house where they lived.

An Australian study of exposure was carried out in the 1970's (Cameron et al,1976 and Cameron,1982). Here observers were placed along stretches of road in Melbourne, to identify the number of vehicles and the number of pedestrians utilizing a road section within a given time period. From this it was possible to calculate the "number of intersecting pedestrian and vehicle paths" (or potential collisions). Observers were asked to record a number of the characteristics about both the vehicles and the pedestrians which could be directly related to variables already identified as being regularly recorded on the Australian road accident form. All age groups of pedestrian were surveyed.

Major findings of the study were that males were involved in a higher proportion of the accidents than females, but also accounted for a higher proportion of the pedestrian exposure than females. The estimated relative risk of males (the proportion of the accidents they accounted for divided by the proportion of the exposure they accounted for) was lower than that for females. However, 0-4 and 5-10 year old males have much higher relative risk than females of the same ages. 0-4 year olds were found to have the highest relative risk (though few accidents to this age group were recorded and possibly the statistics should be treated with caution), being three times more than that of 5-10 year olds and 11-12 times more than that of 11-20 year olds. It was found that pedestrians of all ages had higher relative risk alone than when accompanied, and also when running compared to when walking.

Chapman et al (1980) showed, using a moving observer technique, that an important factor contributing to the sex difference in pedestrian accident statistics amongst children is that boys are exposed to traffic more than girls, and that this greater exposure arises from their making more use of the roads for recreational purposes. It is suggested that once in the road system behavioural differences between the sexes are few and that their general patterns of street activities are rather similar.

In a separate, though similar study they describe a method for the collection of exposure data for children at play, which it is suggested can be done cheaply and easily if it is carried out by students as part of the teaching of fieldwork techniques and subsequent data manipulation and analysis (Chapman and Wade,1982). Observers patrol selected streets in pairs and on foot, passing close to child pedestrians, whose activities are surreptitiously recorded using prescribed categories; one member of the pair records the children's activities and the other records the traffic density. Results from many groups of students can then be brought together and analysed. The major problem with this method is that it does need numerous recorders to work successfully and, apart from the circumstances described in the example where cheap or free labour is readily available, could therefore be time-consuming and expensive.

A study on an estate in Reading (Knighting et al,1972), again using a moving observer technique, found an average of 14.2 children per kilometre on average over 70 daylight hours in a week in the school summer holidays. From their results they found that apart from small differences in the timing of the peak numbers of children seen on the roads, weekends and weekdays in the holidays have roughly the same patterns of activity. Most of the children observed were boys. There was also a high proportion of children in the 5 to 9 age group, perhaps partly explaining the higher accident rate of these children. More children were noted to be stationary in the afternoons than in the mornings, perhaps indicating higher levels of play in the afternoons, and more errand, or definite purpose journeys in the morning. This study, along with that of Chapman et al (1980), both appear to be an improvement on the techniques of Routledge et al (1974a,b, and 1976) discussed above. The 'moving observer' technique seems to combine some of the best features of their 'following' survey and the 'stationary' observation survey. However, there is still a dependence upon the availability of numerous observers if enough results are to be obtained so that variations throughout individual days, and over periods of days are to be identified.

<u>The journeys to and from school</u>

An observation survey in the United States showed that children's trip length on the journeys to and from school is essentially identical for both sexes (Hill,1984). It was shown that boys travel at slightly higher average speeds than girls. Children going home are more inclined to run than a sample of other people (not children), their average speed being 102 metres per minute, compared with 87 metres per minute. Nearly all the children in this sample followed a shortest route.

It has been shown from observing children on their journeys home from school that exposure to traffic increases with age, and that there are developmental changes in crossing strategies (Routledge et al,1974a,b). It was also shown that there were no appreciable sex differences in exposure on journeys home from school, and that children generally finish these journeys within 20 minutes of leaving school. One possible explanation for the differing accident rates of boys and girls, is that girls tend to be accompanied more than boys on journeys to and from school (howarth et al,1974). It was also shown that when interviewed children provide a more accurate idea of exposure on their journeys than their parents do, though there is perhaps still some underestimation of numbers of roads crossed.

Research in Slough (Johnson,1956, and Johnson and Munden,1957), has shown that children's routes to and from school could in the

1950's be changed for the safer by exhortation from their teachers and parents. Observations directly after this exhortation, and again 4.5 months later showed that children were willing to use these safer routes if told how to do so, and to keep on using them. The only factor which militated against this in this particular study was the popularity of a block of shops near the school, which led to some crossing of a main road at a point which had not been recommended. Results showed a reduction in accidents after the scheme was implemented, though because only one school was used in the study, the sample of accidents was far too small for the reduction to be established with statistical significance.

Other studies

To date, few pieces of work have been attempted on anything but a local scale or with aims appreciably wider than testing research methodologies. To carry out a large scale observation study would involve a great deal of manpower, at least if any of the methods described above are to be used. However, one such study has been carried out in the United States (Knoblauch et al,1984). This was aimed at producing a 'defensible national estimate' of pedestrian behaviour. To do this pedestrians were observed at a sample of locations that would allow the observed behaviour to be developed into a national estimate. A total of 12,528 person hours were devoted to observing pedestrians and vehicles at a stratified random sample of locations in 5 SMSA's (Standard Metropolitan Statistical Areas). Volume and activity data were recorded for 612,395 vehicles and 60,906 pedestrians. In addition 20,147 pedestrians were coded by demographic characteristics and behaviour. A total of 1,357 sites were measured, photographed and described. Four types of data were collected:

1. Pedestrian volume data.
2. Vehicle volume and action data.
3. Pedestrian activity sampling data (which includes background information such as age and sex, as well as certain activity characteristics).
4. Other interesting points and site characteristics.

On the basis of their results, they identified a quantity called 'relative hazard' and calculated this for certain groups of the population and certain types of activities. 'Relative hazard' is calculated by assessing whether a factor, such as running, is found more in the accident population than in the exposure population. If this is the case, for example people are not running much but there are a lot of accidents involving running, then the factor is deemed to be hazardous. The degree of hazard depends upon how much more a factor is identified in the accident population than in the exposure population. They found using this method that the pedestrians most at risk are the 1-4 year age group, followed by the 5-9 year age group, the 60+ age group and then the 10-14 year age group. They also found that pedestrians running had a greater chance of an accident than pedestrians walking. Like all exposure studies, the calculation of 'relative hazard' assumes that the other characteristics and behaviour of pedestrians running are the same as those of the different pedestrians who were knocked down while running. To the author's knowledge no study has yet confirmed that this is the case.

2.2.3 Conclusion. Howarth (1982) has identified certain factors which ought to be included in all pedestrian exposure studies. These are:

1. Distance travelled by different classes of pedestrian.
2. Estimate of the number and type of roads crossed.
3. Estimate of the traffic flows of the roads crossed.
4. A classification of the sites of road crossings by type of road layout and pedestrian safety measures used.
5. An estimate of the temporary features of the road crossing such as the presence of parked cars, pedestrian flows and nearness of moving vehicles.

He suggests that it is not possible to obtain all 5 of these from any one of the methods defined by Routledge et al (1976) which were discussed above. Factors 1-3 can be done by both observation and interview methods, whilst factors 4 and 5 must be collected on site. It can be seen that few of the above studies alone achieve anything like these ideals, although in total they have certainly covered most aspects of them. It is unfortunate that this is of less use than all of those factors being covered in one study, as this would be more conducive to comparison.

It seems that up to now, all exposure studies have been a compromise between the information that is needed, and what it is actually possible to do, given the resources and time available. What is needed is a cheap, easy, and reliable method of obtaining useful exposure data. This method should then be standardised and used in all future research so that comparisons can be made between surveys, and the emphasis of work changed from largely theoretical studies of exposure methodology, to more practical studies which can help with the design of preventive measures, particularly at a local level. OECD (1983) distinguish between what they call the 'quantity' of exposure, and the 'quality' of exposure. The former is the average number of roads crossed, or the distance travelled, while the latter refers to the specific situation or location in which it takes place. They say that the majority of research to date has concentrated on the former. This viewpoint is also stressed by Van der Molen (1981) who calls the former 'global specifications'. He says that what is needed are more specific studies, such as the number of roads crossed in particular situations, and with particular traffic intensities.

Several general criticisms of exposure studies exist. Chapman and Wade (1982) list four. These are firstly whether or not we can study routine behaviour and then on the basis of this make statements about 'accident behaviour'. Exposure studies are never carried out at the exact same time as the accidents occurred, and so some assumptions must always be made concerning the consistency of conditions between the two time periods. Accident behaviour cannot be regarded as normal, and it must therefore be questioned whether studies of 'normal behaviour' can be successfully related to accidents. Secondly, there is the problem of the statistical significance of the results. At what level should planners/policy makers decide that changes to the road system or behavioural norms are necessary? Thirdly, it should be stressed that exposure alone is not enough to explain why accidents occurred. We can say that 'it might contribute to differing accident totals', but no more. The fourth problem is more of a moral question, than a methodological one. It concerns the use of observation methods and questions whether we, as researchers, have a right to observe and record people's behaviour without their consent.

Despite these reservations, it seems necessary to once again reiterate the need for exposure studies if our knowledge of the underlying factors behind accidents is to be increased. With this in mind, it is useful now to consider in the next section, studies of the behaviour of children in the road system, as this will give yet further perspective upon accident causality.

2.3 Pedestrian behaviour

It is intended to treat this topic briefly as reviews of the relevant literature already exist (e.g. Van der Molen,1977, Chapman et al,1981, and Firth,1982). In general the aim of studies of pedestrian crossing behaviour has been twofold. Firstly to define how the pedestrian crossing task is carried out, and secondly to see how effective this method is for different groups of people, in particular for different age and sex groups. Methodologically, studies so far have concentrated upon direct observation, either by placing observers in the road system, or by use of electronic surveillance systems such as video cameras. Neither of these has yet successfully removed bias from the observation task.

The actual task analysis carried out by the pedestrian at each road crossing has been described in detail (Older and Grayson,1974). Differences in this crossing strategy between adults and children have been noticed by several workers (e.g. Grayson,1975b). It has been found that adults tend to assess the road situation before reaching the kerb, and in so doing make a high proportion of their head movements on the approach to the kerb. Children more often stop and look when they reach the kerb, and thus make a higher proportion of their head movements at this point. Adults were rarely seen to run, while children quite commonly do so. Adults are more likely to cross a road at an angle than children. In general, children conform more to the ideals of the Green Cross Code, while adults tend to be more concerned with distance or time minimization on their journeys, and so try to cross the road in the most efficient manner. Children look for a safe place to cross, and then worry about the crossing, while adults try to look for a time to cross the road as they walk along. Elderly adults have been shown to adopt a similar road crossing strategy to that of children (Wilson and Grayson,1980).

Factors such as the social situation of the child (i.e. who they were accompanied by) were found to affect the manner of behaviour during the crossing, though no discernible difference was found between the sexes (Grayson,1975b). Chapman, Foot and Wade (1980) also noticed no difference in the heedlessness of boys and girls on the roads. However, Finlayson (1972) found the opposite to be the case. In this study behaviour was classified as 'safe', 'careless', or 'unsafe', and it was shown that more boys than girls acted unpredictably and in an 'unsafe' manner. Howarth and Lightburn (1980) from observations of children's school to home journeys, argue that when boys and girls are involved in similarly difficult encounters with traffic (the study used two types of encounter, a 'distant' encounter where a pedestrian arrives at the pavement at the moment when a vehicle is more than 20 yards away, and a 'close' encounter where the pedestrian and the vehicle come within 20 yards of each other as the pedestrian crosses the road), girls are better able to extricate themselves from those encounters. Heimstra et al (1969) found that girls were more likely to run than boys, but also more likely to observe traffic when approaching the street. However, apart from behaviour in observing traffic, there were few noticeable differences between boys and girls in the types of pedestrian behaviour analysed.

It has also been shown that accompaniment has a marked effect upon crossing behaviour (Grayson,1975b). Children accompanied by adults seem to rely upon their guidance when crossing the road, and play little active part in selection of the crossing location, or in the subsequent action of crossing. Children on their own were more likely to run across the road than children in groups. As well as accompaniment, traffic flow has also been identified as having an effect upon children's behaviour (Finlayson,1972). In conditions of heavy traffic more children were seen to stop at the kerb, and to look both ways, than when there was no traffic.

In general Sandels (1975) has concluded that the traffic behaviour of 4-7 year olds was unreliable, and could be categorized as generally unsafe. A German study interviewing children's parents found that when asked about near accidents, about 50% said their child had been endangered in traffic at least once because it had behaved incorrectly (Limbourg and Gerber,1981). It is thought that the child who dashes into the road is usually preoccupied with something in the immediate environment, or himself (Coote,1976). Unfortunately the emphasis on collision avoidance would seem to rest upon the pedestrian. It has been shown empirically that drivers rely upon pedestrians, even child pedestrians to take any avoiding action that may be necessary to prevent a collision (Howarth and Lightburn,1980).

Studies of behaviour must be considered carefully as they look only at normal crossing behaviour, while it is likely that accidents are the result of abnormal crossing behaviour. That is, accidents might occur the one time in a thousand that a child did not look while crossing. Thus the potential contribution of behavioural studies to the field of road safety must be in some doubt. It would be more relevant, if possible, to look at the behaviour of children when they are either in an accident situation, or a near miss. In this way the behaviour that caused this situation to occur could be assessed. Thus, the information really needed, is how often does behaviour deviate from the norm, and lead to a potential accident situation, and to whom does this occur most. One method of obtaining this sort of information has been tried (Martin and Heimstra,1973). This method used an interview technique to examine children's perception of dangerous circumstances, including a road situation. Results showed that patterns of hazard perception vary with both sex and age. Unfortunately the study did not actually say whether the way in which children perceive hazard has an affect on their behaviour.

Behaviour studies would not appear to have the same potential for providing information about the accident problem as exposure studies. The former to date seem to have concentrated on examining normal behaviour, which has not yet been shown to be the same as that which leads to accidents. Exposure on the other hand is a quantity which, despite the reservations mentioned in Section 2.2.3, can be regarded as an indicator of opportunity for occurrence of accidents.

The previous three sections have all been concerned with the collection of data, aimed at throwing further light upon the accident pattern. The next 2 sections will try to assess how this data has been used to try to prevent accidents, and the relative success of these ventures. To date accident prevention methods have been one of three types, known commonly as the "3 E's". These are Education, Engineering and Enforcement, and each will be discussed to some extent.

2.4 Road safety education

The first of the preventative measures described above which will be discussed is road safety education. Of the three forms of preventative measure, this is probably the one into which most effort specifically related to children has been put, perhaps as it has traditionally been thought of as the easiest approach to reducing the problem of children's road accidents. It is often mistakenly thought that all that is needed to teach children to cross roads safely is to remind them to 'look right, left and then right again', at each crossing. Research is now beginning to show that to be effective, road safety teaching must be far more thorough, well planned, and designed to suit the particular children at which it is aimed. Some would even doubt whether children can be successfully educated at all, arguing that they are not mature enough to be able to take in the ideas involved, and then reapply them to the large number of situations which will be encountered. As stated before, Sandels (1975) would argue that children are "biologically incapable" of managing the demands of the traffic system in it's present state.

It is impossible to estimate accurately how much traffic education children receive both in schools and in the home, as this takes many forms, and is not necessarily straightforward instruction. For instance children learn by observing adults or other children, from television programmes, books and so forth, all of which need not have any intended connection with road safety. Several studies have shown how much deliberate road safety teaching is carried out both at home and at school. In Germany it was shown (Limbourg and Gerber,1981) that most parents do not train their children systematically and continuously, but only at times when they happen to think of it. Predominantly it is the mother who does this.

It has also been shown in England (Sadler,1972) that it is mainly the mother who teaches the children at home. In that study it was found that three quarters of mothers of 5-8 year old children feel that the main responsibility for teaching road safety lies with the parents. The pattern of instruction at home seems to be that at an early age children are taught to cross one or two particular roads at first, but as they grow older they are taught to cross several roads. The most common instruction to children seemed to be to "look both ways" before crossing. It was noticeable from this study, that in many cases either the mothers had no conception of the dangers involved in crossing roads, or they overestimated the ability of their children, as 13% thought that their 2 year old child could cross a road which they themselves classified as 'very busy'.

In the schools this situation is often as depressing. A survey among primary and middle schools in Britain in 1974 (Singh,1976) showed that only 37% included road safety teaching in their curricula. It is likely that the situation in secondary schools would be even worse than this. Of the primary and middle schools, 28% were actively against the inclusion of road safety teaching in their curricula. This attitude may be a result of the "curricular shell shock" (Jolly,1977), that teachers are now suffering from due to the constant bombardment of new ideas, projects, and materials. The study showed that when it is taught, road safety education occurs in many ways. These are: (1) incidentally in classrooms, morning assembly, and elsewhere; (2) as separate lessons from time to time on specific aspects; (3) as part of integrated work on topics such as local roads, transportation, and people who assist in the crossing of roads; (4) as a subject in it's own right; and (5) as talks and demonstrations by policemen and road safety officers (Singh,1982).

2.4.1 Methods of teaching road safety. The materials used, the presentation, and the ideas that are involved in road safety teaching are numerous. These can be classified into several groups on the basis of the degree of reality that they involve. Firstly there are techniques that merely involve direct instruction of theoretical ideas to the child about how he or she should cross the road. Secondly, there are those that involve direct instruction, coupled with some form of simple teaching aid, such as a wall poster or a blackboard at the simple end, and ranging up to expensive teaching packages which include the use of videos, slides, films and other specially designed road safety aids. Finally there is the sort of road safety teaching that actually takes place in realistic conditions which range from artificial road environments in the classroom and outdoors to the actual road environment itself. Research has shown that road safety teaching becomes more effective the more realistic are the conditions under which it is carried out (see for instance

Colbourne,1971, Limbourg and Gerber,1981, Rothengatter,1981, Avery and Avery,1982 and Vinje,1981). That is, while it has not been conclusively shown that groups which are given more realistic training have less accidents in the future than other groups, it has been shown that these groups get better test results when asked questions about road crossing after a period of instruction.

Colbourne (1971) carried out two experiments in training children in road safety teaching. One of these involved taking two similar groups of children, and giving one theoretical instruction in road safety, and the other practical instruction in road safety in a traffic garden. Results showed that the group given instruction in the classroom performed significantly less well when tested afterwards within a traffic garden, than the group who were given practical instruction. It has been suggested that on its own theoretical instruction in road safety is of virtually no use at all in improving the ability of children to cope with traffic (Rothengatter,1981).

Video films of children actually crossing the road have been put forward as a more effective basis for road safety teaching as they give the child direct visual feedback from their actions. Pilot studies of the use of a video recording for traffic education in primary schools have been carried out (Cyster,1981). Results showed that the effect of children seeing themselves and their friends on television improved their ability to recount in detail, up to 2 or 3 weeks later, what they had seen, and that this created a lasting impression upon young children aged five to eleven years. It has been pointed out (Vinje,1981) that care should be taken when choosing to use videos and other such training methods for road safety teaching, as there are limits to the learning capacity of different age groups of children, and some methods may therefore be unsuitable.

Often in the past, road safety teaching material has been accepted without question, and used with little or no regard for the actual benefit the children obtain from it, and any effect that it might have upon reducing accident rates. Recently however, research work has begun to make attempts to test the usefulness and validity of existing road safety teaching materials as a means of improving road crossing performance in children.

A TRRL study assessed the usefulness of the educational techniques used in a film entitled "Mind how you go" produced by the Central Office of Information for the Department of Transport (McGarvie, Davies and Sheppard,1980). In general it was thought that the film was very good, and that children of varied ages could identify with the characters portrayed. However, some criticisms were made, mostly concerning the film's techniques and conventions. Some of the road safety messages the film was meant to put across were thought to be fine for adults, but for a lot of children were sometimes too complex or subtle, and it was thought that these messages ought to have been more directly put across.

A second study highlighted a far more specific criticism about a film entitled "Mary had a little Lamb", produced by the Petroleum Films Bureau (Pease and Preston,1967). The film concerns a schoolgirl's pet lamb who is almost run over. The girl, as a consequence, learns the Kerb Drill at school and endeavours to pass on this knowledge to the lamb. However, it was pointed out that the participants in the film, whose example the audience of children are supposed to follow, all face towards the audience as they perform the

Drill. This action led to confusion amongst the children, as to which side was left and which was right, something which young children are not very good at determining. Simple mistakes such as these are by no means unique, and more care should be taken to ensure that the educational worth of future films and other materials, are not reduced in this way.

As well as the above methods used to teach road safety, some of which are very individualised and may be used or taught differently to various groups of children, there have traditionally in this country been widespread, or even national road safety campaigns which receive large scale publicity and seem to provide a basis on which most road safety can be taught at a local scale. The more well known ones of these include Playstreets, the Kerb Drill, the Green Cross Code, the Tufty Club, and other more recent Traffic Clubs. The nature and effect of these will now be considered in turn.

Playstreets

This was probably one of the earliest ideas in road safety teaching/engineering (Godfrey,1937). Playstreets are roads in which access by through traffic is restricted, normally so that only residents or access traffic are allowed to use them. They were developed with aim of directing children's play towards roads where there would be very little traffic, and away from the more major roads with fast moving traffic. It was considered, quite rightly, that as long as children and fast moving cars shared the same areas, then children would continue to be injured. Where play streets were introduced, campaigns were launched in their local areas to inform the parents and children of the safety advantages of using them. In this country these streets are not very widespread at present, perhaps because the idea never caught on, or because children could not be persuaded to use them as they represented a restriction of their freedom. There have, however, been more recent adaptations of this kind of idea abroad, for instance in Holland with the 'Woonerf' or 'environmental area' concept, whereby physical changes to the road network have meant that through traffic is barred from certain residential areas, and that residential access traffic must travel very slowly.

The Kerb Drill

This was first introduced as a road safety teaching method in 1942 by The Royal Society for the Prevention of Accidents (RoSPA). It is probably one of the best known teaching methods, especially with those of us who were youngsters at school before 1974 when the Green Cross Code took its place. However, the Kerb Drill, with its familiar "look right, look left" chants has been much criticised as a safety method for a variety of reasons. One of these was that children misinterpreted the way it was intended to be used. Children have been shown to look on it as a lucky charm. To them, as long as it was rehearsed correctly when crossing then their safety was assured, regardless of whether traffic was coming or not. It has been shown that most children can adequately remember the instructions, but that their understanding of how to apply them to street situations is sometimes in doubt. Because of this, and the many changes in the volume and speed of traffic that have occurred since the Kerb Drill was introduced, it was decided to produce a new set of crossing instructions which were more geared to present day conditions.

The Green Cross Code

This was first tested with the aid of 170 seven and eight year old children working at the roadside (Sargent and Sheppard,1974). These children were asked to justify their choice of a safe place to cross, and to say whether they knew of any other safe places to cross. The study concluded that given guidance and instruction, children between 7 and 8 years of age would be able to read and carry out the Green Cross Code without very much difficulty. However it was thought possible that even after instruction, the task of identifying safe places to cross might still prove to be too difficult for them. During the three months that followed the introduction of the Green Cross Code and the associated road safety campaign there was said to be a reduction in child pedestrian casualties of around 11% (Russam,1975), however this was never conclusively shown, as the methods of evaluation were often in doubt (Grayson,1981). It is likely that much of the publicised reduction in accidents was due to propaganda at the time, and not because of anything intrinsic to the code (Preston,1980). The effectiveness of the Green Cross Code is thought to be related to the way it is taught. A study after the introduction of the Code, took 86 children aged from 5 years 5 months to 8 years 4 months and instructed and tested them on the TRRL 'small road system' (Fisk and Cliffe,1975). Following one lesson on the Green Cross Code they were asked to make a road crossing. Results showed that age is an important variable in crossing behaviour and also in children's understanding and ability to use the Code. For the younger children they tested, it was found that one lesson on the code was ineffective. It would seem therefore, that although the Code obviously has some effect on some children, there can be no simple recipe which will allow us to identify training objectives, and thus design solutions to the accident problem. A danger is that children often see crossing codes as just such a solution (Grayson,1981). It is thought that more success could be gained if children are taught rules that are more adaptable to different situations. They must be taught to recognise basic situations and then to obtain a realistic insight as to what their options are in such situations (Michon,1981).

One of the problems of a lot of road safety teaching methods to date, including the Green Cross Code, is the way in which they are perceived by children. It has been said, perhaps slightly overstating the problem, that children are being taught to associate safety with fat, bespectacled middle aged office workers whom they would not wish to emulate, and that the Code, at least in its first few years, does little to dispel this image (Williams,1980 quoted in Preston,1980).

A major criticism of both the Kerb Drill and the Green Cross Code, is that too little time is devoted to their teaching, and they are of little use on main roads. This last comment arises because the code relies on a child waiting at the side of the road until a large enough gap in the traffic appears. On many sorts of roads a more sophisticated crossing strategy is required, unless time is of no consequence, as few gaps of a suitable size will appear. As time would seem to be important for children, just as it is for adults, it is not inconceivable that a child will take risks when the wait becomes too long, for which he or she is in no way prepared by the Green Cross Code.

A further problem involves the ability of children to restrict their natural impulsiveness. In some ways cognitive training methods such as the Kerb Drill and Green Cross Code are virtually useless, as in certain circumstances children have little control over their attention and a deficient regulatory system to inhibit impulses, and so will often forget to use these methods (Vinje,1981).

Some attempts at behavioural training have been made. A study in the United States (Reading,1973) attempted to reinforce certain types of good behaviour displayed by children, by using rewards such as badges or certificates. This study claimed some success, though critics point out that children may become overconfident, and develop ideas of invulnerability, once they have received the rewards for good behaviour. It was also not shown how often ideas would need to be reinforced, and presumably after a time the rewards will need to be changed, or become greater.

One other attempt at behavioural training was suggested as part of a parental road safety training program in Tubingen (reported in Downing,1981). One of the aims of this scheme was for parents to train their children always to stop at the kerb. One suggested method of doing this was to incite the child to run across the road (by hiding a toy or a sweet on the other side), and then to stop them each time they tried to run across. In this way it would be imprinted in their minds that running across roads was the wrong thing to do.

Tufty and other pre school traffic clubs for children

The Tufty Club was publicised through the mediums of television and books. The club was launched in 1961 by RoSPA. In 1971 an inquiry was launched to try to assess or evaluate its success or otherwise (Firth,1973). It was found that in general the opinions of teachers and a variety of other road safety orientated groups were in favour of the club and the material it produced. However, further research along the same lines showed that while the Tufty series was very good at teaching the individual child road safety, it was little use for groups. Tufty was well liked by children, and despite frequent criticisms that it was unreal (the main characters are animals) it was found that there was no difficulty in relating the fantasy world of Tufty to 'real-life' situations. It was found that children's road crossing knowledge improved significantly after the book had been read to them.

Problems with this and other similar traffic clubs perhaps centre around the audience who receive the training. Tufty club membership involved a small fee, and also depended greatly upon television ownership. It is possible that certain sections of the community were prevented from joining the club because of this. Also a child's chance of joining seems to depend too much upon their parent's awareness of the club, and also their enthusiasm for training their child in road safety. It is perhaps likely that the children who joined, predominantly came from families where road safety was already a part of family life, and therefore perhaps the children who stood to benefit most from membership, were excluded.

Recently there have been a series of attempts to create, and evaluate the success of, different types of traffic club, largely aimed at pre-school children who it is thought have little other contact with road safety teaching. Research has suggested that a lot of parents need training in how best to teach their pre-school children the rudiments of road safety education (Downing,1981). A Norwegian traffic club sends its members every 6 months a set of printed material, partly aimed at children, and partly at their parents. The effects of this were evaluated (Schioldborg,1976). Members and non-members were tested on traffic knowledge, traffic behaviour, and risk level. The results of the traffic knowledge test clearly indicate a better performance by the club members. However, the behavioural results are not so clear. Theoretical instruction seems to be effective in communicating traffic knowledge, but its effect upon traffic behaviour is less than clear.

2.4.2 The feasibility of traffic safety education. This section examines some of the physical attributes of children, which make it difficult for them to perform as well as adults in the road environment. A lot of research has been carried out to find out the exact limitations of children in respect of various of their senses (see for instance work by Sandels,1975 or Vinje,1981). The basic findings of this work will be outlined here.

Due to their lower eye level, children have a limited field of view. This means they cannot see some traffic due to parked cars, and also that they have fewer opportunities to survey a traffic situation, even if they could process what they see as adequately as an adult. They have a restricted capacity to obtain and use information in the periphery of the visual field. In adults this area of sight is especially sensitive. Children need more time than adults to react once objects in the periphery are spotted. Up to 10 years of age, it is thought that children have poor visual acuity, or ability to resolve objects they see. Children have problems when scanning a visual field, as they are less able than adults to make a planned search in connection with what they are looking for (in this case traffic), but rather their search process is almost totally directed by the conspicuous parts of the visual field. Irrelevant aspects in terms of traffic are often attended to, for instance animals, playing children, or an ice cream van. Until the age of 5 years control of attention is almost totally lacking.

Auditory ability in children is also poorer than that of adults. It has been shown that 6 year olds have problems in localising sounds coming from right or left. Children are also much more unreliable at estimating distances than adults. They have a lack of knowledge of what speed to expect from various sorts of vehicles. Children have no concept of real time, and find it difficult to estimate how long it will be before a vehicle hits them. Problems exist in their perception of risk, in their understanding of the limitations of the visual field, in their knowledge of the concepts of left and right, in their route planning, in their understanding of instructions, and in their understanding of road signs.

It is not thought that anything can actually be done to improve these physical and perceptual skills for children in general. However, it is considered that they can and should be taken into account by all those producing educational material for children regarding safe methods of crossing roads, by all those planning traffic safety schemes, and by all drivers as they use the roads.

2.4.3 Conclusion. Fundamental criticisms of road safety teaching still remain as the above discussion has shown. Two main themes of criticism exist. Firstly, there has been very little substantiation of the behavioural effects on children of most of the teaching methods used to date. Secondly there is the small amount of evaluation that it has been possible to carry out on particular schemes. Certainly in the past, evaluation of teaching methods seems either not to have been considered, or to have come low on the list of priorities of the people involved. If, as was often the case, the teaching method involved had no real effect upon accident rates, then the resource input (sometimes considerable) would be wasted. It is also possible that such a method might have a detrimental effect upon children, due to its promotion of a feeling of overconfidence once the training course has been completed.

More recently there have been some attempts at evaluation of road safety teaching techniques. It is, however, unfortunately still true to say that no direct relationship between a road safety education technique and a subsequent change in accident totals has been adequately established. Possibly because of this poor record, further educational techniques might be better aimed at driver education, in particular concentrating on teaching them how not to knock children over.

2.5 Other areas of preventative research

As mentioned above there are essentially two other main areas of accident prevention research. These are enforcement and road engineering techniques, both of which are aimed largely at drivers, in an attempt to change their driving behaviour. Both of these fields are very wide, and so it will not be possible here to do more than indicate some of the more up to date ideas in each area.

Levels of enforcement of traffic rules in this country are not, and probably never have been very high, and apart from particular 'crackdowns' such as drink driving enforcement at Christmas, or 'speed check' zones, any given traffic offender who is not involved in an accident as a result is unlikely to be caught. The reason generally given for this lack of enforcement is the low level of police manpower which can be spared for traffic duty. This is unfortunate as a strong area of research today suggests that there ought to be changes in the law regarding responsibility for road accidents. The suggestion is that responsibility for a child pedestrian accioent in certain residential areas should be placed more on the driver of the car, than on the child, and that the standard excuse "the child ran out in front of me and I couldn't stop" should no longer be considered valid. By defining residential areas with signs, and by promoting the idea that once in these areas speeds ought to be low, and that if a child runs out in front of a moving vehicle, then that vehicle should be able to stop in time, it is thought possible to reduce the numbers of accidents to children. Although a potentially very useful scheme in terms of reducing the numbers of road accidents to child pedestrians in residential areas, it is perhaps unlikely that it will be implemented in the near future, because as well as requiring changes to be made to existing laws, it will also require a substantial change in drivers attitudes (for further ideas on this see reports by Howarth and Repetto-Wright,1978, Howarth and Lightburn,1981 and Howarth and Gunn,1982).

Perhaps more research time, and more money have so far been spent on engineering measures, designed to make the road system safer. Traditionally these have concentrated on the 'blackspot' approach, whereby locations with a lot of accidents are treated with remedial measures, and hopefully the accident occurrence there is reduced from its exceptionately high level. This site specific method is particularly successful, and will probably continue to be so. However, it does not allow for accidents which are spread out through residential areas in ones and twos, and thus take place at scattered locations which cannot be classified as 'blackspots'. A large proportion of child pedestrian accidents are of this type. Two recent, and related ideas have attempted to try to reduce these accidents which cannot be treated by the blackspot approach, though it should be said that neither was designed specifically with child pedestrians in mind.

The first of these consists of 'area wide' engineering measures. The aim is to use a package of measures designed to improve conditions throughout an area (Dalby,1979). By a restructuring of the road hierarchy it is thought possible to keep through traffic away from residential areas, to help main roads absorb the extra traffic thus produced, and to make it safer to enter and leave the main road system. Pilot studies of this method in this country have shown that it is likely to be successful in these aims, as well as bringing about a reduction in accidents, not only to car drivers, but also to pedestrians due to the reduced level of through traffic on residential roads. One criticism of this method is that, in this country at least, many of the measures that it is desirable to use, such as speed humps and raised crossings, are either not yet allowed (as in the latter case), or are unpopular with the public (as in the former case).

The second of the ideas which has been used widely abroad, particularly in Holland, is the concept of 'Woonerven'. These consist of a clearly identified "area within which the residential function predominates over provision for vehicles, and this fact is expressed through the physical design and layout of the streets and other public areas. The design is attractive to pedestrians with paving, trees, planting, lighting, children's play equipment, and other features set out to create a welcoming atmosphere" (Pharoah,1983,p15). The areas are designed so that there is no clear cut space for cars and pedestrians. Speed reduction features make it very difficult or uncomfortable for vehicles to proceed faster than walking pace. The method is seemingly very successful, perhaps especially in increasing the safety of child pedestrians. Problems do exist though, as its success relies greatly on driver cooperation, both in parking and in the speed of travel. The areas in which 'Woonerven' can be created are limited to residential areas with low traffic volumes, the process of creation is very expensive, and to do so also involves a lot of 'red tape', as in Holland at least, it requires changes in traffic law.

2.6 Conclusion

This chapter has examined some of the work which has been carried out to date regarding road accidents to child pedestrians. The chapter was split into 5 main sections, into which it is thought most of the research to date falls. These were statistical analyses of road accident data, surveys of children's exposure to risk, children's behaviour, road safety education, and other areas of preventative research.

The aim of this chapter, as well as documenting the major areas of research to date, has been to highlight areas where this is either limited in scope and extent, or in quality, and thus where further research would be of most use. The discussions above indicate that further research is needed to define the patterns of road accidents to child pedestrians, and the patterns of use that children make of the roads as pedestrians. This present study provides an opportunity to carry out such research. It was shown that new methods of obtaining detailed information on children's exposure to risk were needed. These should be such that they could be carried out easily and efficiently both in terms of expense and labour. Methods need to be developed which can examine children's exposure to risk for the different types of use that they make of the road systems, in particular the journeys to and from school, and while at play. Once this information has been collected, it needs to be related to accident statistics to produce measures of 'relative risk' or accident risk for different groups of the child population, at different times of the day, and in different sorts of location.

The remainder of this thesis describes work which was carried out to try to achieve some of these aims.

CHAPTER 3

THE FIVE STUDY AREAS AND ROAD ACCIDENTS TO CHILDREN IN THEM

As shown in Chapter 2, in order to understand something about the causes of road accidents to child pedestrians, it is first necessary to find out about the types of children they are occurring to, when they are occurring, where they are occurring, who else was involved, what sort of conditions were prevalent at the time, and what happened. This information can then provide a necessary basis for further research to be carried out to examine possible causes of the accidents. This research could take the form of a study of exposure, or of children's behaviour. The accident analyses will not only play an integral part in these further analyses (for instance when working out the risk of an accident to various groups of children from exposure measures), but will also help in deciding what types of further analysis should be carried out, and the best way to do these so that comparisons between the data sets can be easily and usefully made. The study is based on five small areas each of which is largely residential in character. Within this chapter an outline of the location and reasons for the choice of these areas, and a brief background description of them will be given before analysing the accidents occurring in them.

Since the completion of the thesis it has come to the notice of the author that the sample of accidents to child pedestrians in the Bristol study area used in this study was in fact missing a number of accidents. An extra 11 accidents to child pedestrians have come to light, which due to an error in the process of transferring the information from police notebook to Local Authority accident data tape, were not previously known about. There is no reason to suggest that these missing accidents were anything but randomly omitted from the accident tape and therefore it is to be expected that they will display the same characteristics as the sample of 95 accidents already analysed for the Bristol study area. For this reason it is not intended to include these extra accidents generally in the analyses discussed in this and later chapters. However, there are a number of occasions where it is thought that not including these accidents would seriously affect the reliability of the results and the conclusions based upon them. In these cases the extra accidents have been included. There are two such instances in Chapter 3, both in Section 3.4, where comparisons of the number of accidents per head of population and per square kilometre are made between the study areas. Also, because two of the 11 extra accidents occurred on journeys to or from school, the analyses of accident risk on the journeys to and from school in Section 6.3 have all been amended to take account of these accidents. No changes were made to the analyses of relative risk in Section 8.7, as none of the extra 11 accidents occurred in the relevant time periods or locations.

3.1 The study areas: location and reasons for choice

The five areas chosen for this study were parts of Bradford, Bristol, Nelson, Reading, and Sheffield. In the case of four of these the study area was a small, largely residential, part of the whole town or city. In the fifth, Nelson, the study area consisted of virtually the whole town, except for the central area which did not conform to the residential characteristics required. The extent of the study areas is shown in Figures 3.1-3.5. These also show the locations of the schools, and all of the shops in the areas.

The five areas were selected by the linked project, the TRRL Urban Safety Project. Some of the reasons behind the choice of areas will be considered here so that an idea of the context in which the present project is set can be gained. Firstly each of the areas chosen was supposed to have between about 100 and 120 injury accidents per year. Secondly the buildings, the road network, and other physical features of the areas should be expected to remain reasonably stable for the period of the Urban Safety Project, so that the 'before and after' accident analyses, upon which this project largely depends, can be carried out as reliably as possible. Thirdly the edges of the areas should, where possible, follow lines of natural or artificial boundaries such as main roads, the edge of an urban area, railways, or rivers. This limits to a manageable number the places where traffic can either enter or leave the areas, and so minimizes the effect that any external changes might have upon the accident patterns within them.

3.2 A brief background description of the study areas

The aim of this background description is to give the reader some feeling for the differences and similarities of the areas being studied, before more detailed data analyses are made later in the study. The first part of the description will examine some of the population characteristics of the areas. Secondly some other background characteristics of each of the areas in turn will be considered. Particular emphasis will be placed upon features related to children, and to their use of the roads. Some of these characteristics will be considered in this and later chapters in relation to accident and exposure patterns.

Table 3.1 shows the populations in each of the study areas, broken down into various age groups. This shows that of the 5 study areas, Sheffield has the biggest population with just over 51,000 people (all these figures relate to the 1981 census), followed by Reading with nearly 39000. The other three areas all have between 29000 and 33000 people. In each of the areas there are in total more females than males (between 51.0% and 52.1% females). However, for the child population, in each area there are more males than females (between 51.1% and 52.5% males). Children under 16 years of age account for only 19.4% of the total population in Sheffield, while in both Nelson and Bradford, they account for 24.0%.

Table 3.2 shows some of the employment characteristics of each of the study areas.

Table 3.1: Study area populations (all figures except the base are percentages).

Age	Bradford		Bristol		Nelson		Reading		Sheffield	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Children:										
0-4 years	3.4	3.4	2.8	2.8	4.1	3.7	3.1	3.0	2.2	2.1
5-9 years	3.6	3.4	3.3	3.0	3.8	3.4	3.4	3.2	2.8	2.7
10-15 years	5.3	4.9	5.2	4.8	4.7	4.3	5.2	4.9	4.9	4.7
Total	12.3	11.7	11.3	10.6	12.6	11.4	11.7	11.1	9.9	9.5
Adults:										
16-59 years	28.6	28.8	27.8	28.3	27.3	26.7	29.8	29.0	26.3	26.1
60+ years	7.4	11.2	9.4	12.6	8.7	13.3	7.5	10.9	11.7	16.5
Total	36.0	40.0	37.2	40.9	36.0	40.0	37.3	39.9	38.0	42.6
Base	15735	16883	15380	16386	14158	14997	19074	19815	24558	26649
Percent total	100.0		100.0		100.0		100.0		100.0	

Source: 1981 Census of Population.

Table 3.2: Employment characteristics within the study areas (figures in the table only include persons over 16 years of age).

	Bradford		Bristol		Nelson		Reading		Sheffield	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Economically active population:										
Working	8027	6062	7891	5517	6927	4720	10957	7436	11236	8234
a.Seeking work	1261	440	1003	292	912	543	821	338	2403	609
Other	92	40	89	44	131	91	98	48	328	115
b.Total	9380	6542	8983	5853	7970	5354	11876	7822	13967	8958
c. Economically inactive population	2340	6547	2807	7166	2517	6336	2638	7653	5529	12833
d. Total	11720	13089	11790	13019	10487	11690	14514	15475	19496	21791
a/b x 100	13.4%	6.7%	11.2%	5.0%	11.4%	10.1%	6.9%	4.3%	17.2%	6.8%
c/d x 100	20.0%	50.0%	23.8%	55.0%	24.0%	54.2%	18.2%	49.5%	28.4%	58.9%

Source: 1981 Census of population.

It can be seen that there are some large differences, both within the areas between the sexes and also between the areas, in terms of the proportions of people working and the economically inactive populations. In each of the areas there are a greater proportion of males seeking work than females. It can be seen that Sheffield has by far the highest proportion of men seeking work, and also the highest total proportion of people seeking work. Nelson has the highest proportion of women seeking work, while Reading has the lowest proportion of both men and women seeking work. Sheffield has the highest proportion of economically inactive people, both for males and females, while Reading again has the lowest levels of both.

It would appear from considering these figures that the Sheffield study area and, to a lesser extent, the Nelson Study Area would not rate as highly on a scale of economic and social well being as the other areas, particularly Bristol and Reading, if the evidence above is used as the measure. Adding strength to this argument, Table 3.3 shows the levels of car ownership in the areas.

Table 3.3: Levels of car ownership in the study areas.

	Bradford	Bristol	Nelson	Reading	Sheffield
households not owning a car:					
Number	5900	4476	5915	5487	12962
Percentage of all households	49.8	38.8	53.3	39.2	64.7
Number of cars per person	0.22	0.28	0.21	0.28	0.16

Source: 1981 Census of population.

This is of interest in two ways: firstly as an indicator of economic well being; and secondly as an indicator of the levels of traffic in the areas, especially on non-through routes. As can be seen the areas with the lowest proportion of households not owning a car, and also the highest number of cars per person are Reading and Bristol. The area with the lowest proportion of cars per person is Sheffield.

The above gives a brief introduction to some census characteristics of the study areas. It is important to note that there are some differences in the social and economic background to the areas, and that some of these features may be reflected in the accident and exposure patterns which will be analysed later in the thesis. Other characteristics of the areas are also likely to have an effect upon these, and will be documented below for each area in turn.

3.2.1 Bradford. The study area is located 2 miles to the south west of the city centre. Its exact location is shown in Figure 3.1. It covers an area of 8.7 square kilometres. The majority of land in this area is given over to residential use, with private houses predominating. Only 29.1% of the residents live in council owned houses. Figure 3.1 shows the locations of the shops and of the schools in the area. There are 11 First schools, five Middle schools and one Secondary school (see Appendix A.1 for a definition of the different types of school). The population of children attending schools in the area is 5931 (in 1983/4). Within the area there are several stretches of open space where children might play, in particular Harold and Wibsey Parks. There is also a large sports centre just outside the area at Odsal. There is only one shopping centre of any size which is along the Wibsey High Street. Apart from this there are a few neighbourhood centres, and individual shops.

3.2.2 Bristol. The study area is about 2 miles north of the city centre. It covers an area of 7.7 square kilometres. It is centred upon the council estates around Southmead and the older, mostly private, developments to the north-w st in Henbury village. 52.9% of the residents live in council owned houses. Figure 3.2 shows the locations of the shops and of the schools in the area. There are 10 primary schools (one of which is Roman Catholic), each having an infant and junior section, and 4 secondary schools (two mixed sex, one boys only and one girls only). There is also one school for the educationally sub normal (ESN). The school population was 7163 in April 1982. There are several areas of unsupervised playspace, ranging from purposely built play parks, to areas of open ground between houses. Also there is an indoor swimming pool (Crow Lane), and an adventure playground (Doncaster Road), as well as a sports centre just outside the area (Elm Park). The biggest group of shops is at Arnside, which is virtually in the geographic centre of the area. This is sufficiently large to contain a Woolworth's.

3.2.3 Nelson. This area is in the Pendle District, towards the eastern edge of Lancashire. It differs from the others in that it consists of most of a complete town, with only a small part of the central area omitted. It is a fairly 'typical' old Lancashire mill town, built in a valley, with predominantly terraced houses and many cobbled streets. The study area covers 8.2 square kilometres. Only 17.4% of the residents live in council owned houses. Figure 3.3 shows the locations of the shops (note the predominance of 'corner shops') and the schools. There are 11 primary schools (2 Roman Catholic), each of which contains an infant and junior section, and 2 secondary schools. There is also a sixth form/tertiary college and two special schools (ESN). The population of children attending schools in the area is 4880.

There are few areas of open space, the main ones being Marsden, Walverden and Victoria Parks. There is also some space along the canal, and some derelict sites, though the location of these is changing as more houses are built, and others knocked down. The central area of Nelson (the portion not in the study area) is largely devoted to shops. These are based around the new 'Arndale' indoor shopping centre. Aside from this, and the area along the Leeds Road, there are no big centres, though there are a lot of corner shops in ones, twos or threes.

3.2.4 Reading. The study area is directly to the west of the town centre. It covers an area of 8.8 square kilometres. Within the area 28.0% of the residents live in council owned houses. Figure 3.4 shows the distribution of shops and the schools. There are 11 infant schools (one of which is Roman Catholic), 12 junior schools (one of which is Roman Catholic) and 5 secondary schools (one independent, one boys only, one girls only and two mixed sex comprehensives). In April 1982 there was a school population of 7699 pupils. There is one large purpose built playpark (Prospect Park) and several other areas of open land. There is also one sports centre, with a swimming pool (Meadway). There are two main shopping centres. These are firstly along the Oxford Road from the railway bridge to Grovelands road and secondly in Honey End Lane where there is a modern complex with a large supermarket. Aside from these, there are several other neighbourhood centres.

3.2.5 Sheffield. This is the biggest area, covering 11.3 square kilometres. It lies just to the north of the city centre. 87.0% of the residents in this area live in council owned houses. Figure 3.5 shows the distribution of shops and schools. There are 11 first schools, 1 Roman Catholic infant school, 9 middle schools, 1 Roman Catholic junior school and 6 secondary schools (one of which is Roman Catholic). There is also one special school (ESN). The area has a school population of 10597, though unlike the other areas, this figure includes nursery schools, which in many cases occupy the same sites as the first schools. There are three main purpose built playparks (Longley, Parson Cross and Concorde), and several other areas of open space. There is one open air swimming pool in Longley Park. Within the area there is no dominant shopping centre. However there are numerous neighbourhood centres, of the sort typical of council estates, as well as some individual shops.

3.3 Accidents included in the study

The main focus of attention of this study was on the nature of road accidents to child pedestrians. Information regarding these accidents was provided by the 5 Local Authorities involved. This data contained the basic 'Stats 19' variables (see Appendix A.2 for a copy of the form, showing the variables it includes). Some variables from this, which were thought particularly relevant to child pedestrian accidents, were transferred to a statistical analysis package called

Statistical Analysis System (SAS,1982). Other information, such as the type of road the accident happened on, or the occurrence of the accidents outside the child's school, was worked out from the information given in 'Stats 19' and added to the data set on SAS. Using this data set it was possible to carry out detailed breakdowns and statistical descriptions of the accident data. This chapter describes the results of these.

'Stats 19' data include by definition "only accidents involving personal injury occurring on the public highway and in which one or more vehicles are involved" (DTp.,1978, p2). It is important to note, that although ideally 'Stats 19' should contain all accidents which fit the above description, in practice this is not the case, as was discussed in Section 2.1.1. All data used in the following analyses relate to the 6 years from 1979-1984. Additional information concerning the accidents, to supplement the 'Stats 19' data, was collected from local police accident records.

For the purposes of this study children were defined as being under the minimum school leaving age of 16 years. This means that 16 year olds were only included in the analyses if their accident occurred while they were still attending a school.

3.4 Accident types in the study areas

So that the problem of child pedestrian accidents in the study areas can be seen in a wider perspective, Table 3.4 shows the proportions of accidents to various types of road users.

Table 3.4: Numbers of child and adult pedestrian accidents in the five study areas (all figures except the base are percentages).

Type of pedestrian	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Children	56.2	51.4	68.7	57.0	56.2	58.4
Adults:						
16-59	31.5	25.4	15.1	28.8	23.7	24.4
60+	12.3	23.2	16.2	12.7	20.1	16.9
Unknown	0.0	0.0	0.0	1.5	0.0	0.3
Base	219	185	259	205	279	1147

The table shows that child pedestrians account for more than half of the pedestrian accidents in each of the study areas. There is also some variation in the proportions of accidents to child pedestrians between the areas. This ranges from Bristol where just over half of the pedestrian accidents are to children, to Nelson where the figure is just over two thirds. Nationally 55.0% of pedestrian accidents were to adults (over 16 years) in 1983 (DTp.,1984), while only 45.0% were to children (0-16 years). However it must be remembered that these figures cover all sorts of areas in the country, while the statistics for the present study include only suburban areas where the proportion of child pedestrians involved can be expected to be higher (Faulkner,1975).

It can also be seen from Table 3.4 that there are a sizeable proportion of accidents to elderly pedestrians (60+) in the study areas, although it is only in Nelson that this is higher than accidents to adults aged 16-59. It can be seen that for all the areas together there are less than half as many accidents to adults in the so called 'economically active' age group (16-59) as there are to children. This is particularly extreme in Nelson where there are over four and a half times as many accidents to children as there are to adults aged 16-59.

It is not possible to comment on the relative numbers of accidents to child pedestrians in each of the study areas as they are shown in Table 3.4 because the areas differ so much in size. However, if accident figures from Table 3.4 are combined with population figures from Table 3.1 it is possible to work out a rate of accidents for each of the areas, which is directly comparable between them. It can be shown in this way that Nelson has by far the highest number of child pedestrian accidents per 1000 resident children with 25.4, followed by Sheffield, Bradford and Bristol with 15.8, 15.7 and 15.2 respectively, and finally Reading with 13.2. The fact that the Reading area has the lowest rate of accidents could tie in with some of the evidence found in Tables 3.2 and 3.3 which shows that on a scale of economic and social well being this area would be the highest of the five. Similar ideas were suggested by Preston (1972) who showed that in Manchester and Salford the number of accidents to child pedestrians was related to the socio-economic background of the areas in which the children lived.

It is also possible to consider the numbers of child pedestrian accidents per square kilometre per year in each of the study areas.

The pattern is similar to that obtained when using population, with Nelson having a value of 3.6, followed by Bradford with 2.4, Sheffield and Bristol with 2.3, and Reading with 2.2. The large size of the Sheffield area means that by using this measure it has a very similar accident rate to Bradford, Bristol, and Reading. Nelson still has the highest rate using this measure. It should be noted that these figures do not take into account the density of roads in the areas, which particularly in Nelson is very high.

3.5 The type of child involved

'Stats 19' contains two main pieces of background information about the child involved in an accident. These are the sex and age of the child.

3.5.1 The sex of the child. Table 3.5 shows the proportions of each sex involved in the child pedestrian accidents in the five areas.

Table 3.5: Accidents to child pedestrians by the sex of the child involved for each area (all figures except the base are percentages).

	Area					
Sex of child	Bradford	Bristol	Nelson	Reading	Sheffield	All areas
Male	61.0	50.5	64.6	53.8	53.5	57.5
Female	39.0	49.5	35.4	46.2	46.5	42.5
Base	123	95	178	117	157	670

It can be seen that there is some variation in the proportions of accidents to each sex between the areas. The corresponding value of χ^2 with 4 degrees of freedom is 8.04 ($0.05<p<0.10$), so that the difference is not very likely to have arisen by chance. Table 3.1 shows that there are only slightly more boys than girls in the areas, and that between the areas there is almost no variation in the proportions of each sex, and it is thus unlikely that the variation between areas in the proportions of accidents to the sexes is due to different levels of population of boys and girls. In the Bradford and Nelson areas the proportion of accidents to boys is higher than in the other three areas.

Table 3.5 shows that boys have more accidents than girls, roughly in the ratio 3:2. Other studies of road accidents to child pedestrians have found similar differences between the number of accidents to the sexes (for instance Grayson,1975a, Sandels,1970, Chapman et al,1981). Nationally in 1983, 61.2% of the accidents to child pedestrians of less than 16 years of age were to boys, while only 38.8% were to girls (DTp.,1984). Possible explanations for this difference may lie in different levels of exposure of the sexes, or different types of behaviour. The former idea implies that boys must come into potential conflict with vehicles more often than girls, the latter, that boys are more liable to accidents than girls when in a given traffic situation. As Chapter 2 has shown, research into these ideas does not seem to be conclusive.

Table 3.6 shows national exposure figures from the 1978/79 National Travel Survey (DTp.,1983a), obtained in the course of other research in the Transport Studies Group. These are the average mileage walked per person and the average number of walk stages per person, for different age and sex groups.

Table 3.6: Usage of the road network for walking in a typical week by age and sex of pedestrian.

Age	Sex			
	Male		Female	
	Mileage	Walkstages	Mileage	Walkstages
0-4 years	5.4	9.8	5.4	10.1
5-10 years	5.1	11.1	4.8	10.7
11-15 years	7.9	13.9	8.0	15.0
16-59 years	4.5	8.2	5.6	11.1
60+ years	6.1	9.5	4.0	7.8

This table indicates little or no difference in exposure between boys and girls, though there are differences between men and women later in life.

Plots of the distribution of the accidents by the sex of the child involved have been made for each of the five areas (see Appendix A.3 Figures 1 to 5). The first noticeable thing about these diagrams, is the spread of accidents throughout the areas, and the relatively few clusters which occur. Although it can be seen that a lot of the accidents are on main roads (Appendix A.4, Figures 1 to 5 show the road hierarchy in each of the areas), there are also numerous accidents spread about within the residential areas themselves. There are some differences between the types of locations of the accidents occurring to boys and to girls. Table 3.7 shows the number of accidents to each sex in each area, on main and other roads.

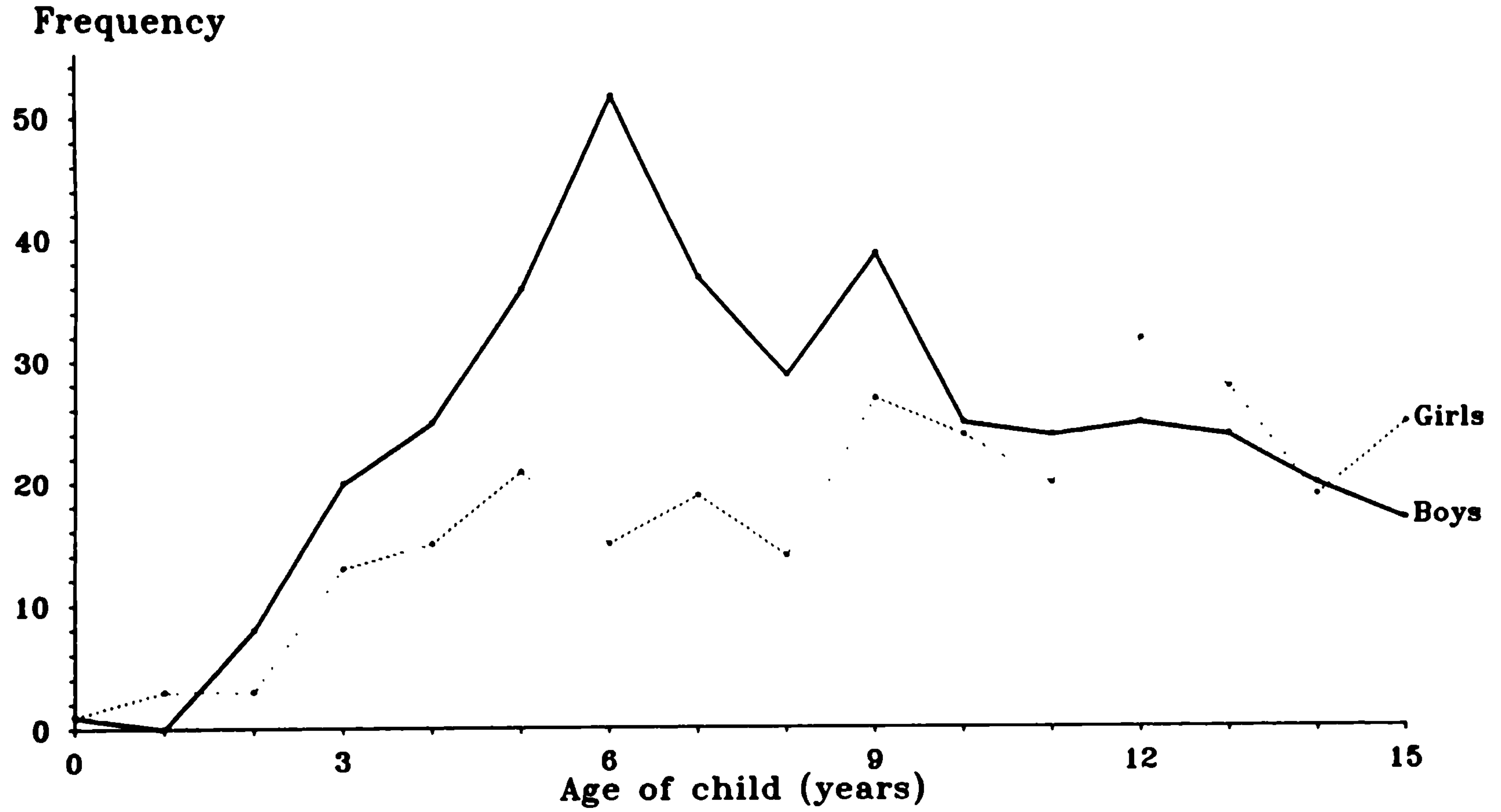
Table 3.7: Accidents to child pedestrians by sex and type of road for each of the five study areas (1979-1984).

Sex of child and type of road	Area										All areas	
	Bradford		Bristol		Nelson		Reading		Sheffield			
	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent
Boys												
Main road	43	57.3	29	60.4	72	62.6	38	60.3	56	66.7	238	61.8
Other road	32	42.7	19	39.6	43	37.4	25	39.7	28	33.3	147	38.2
Girls												
Main road	31	64.6	39	83.0	42	66.7	38	70.4	56	76.7	206	72.3
Other road	17	35.4	8	17.0	21	33.3	16	29.6	17	23.3	79	27.7

As can be seen a greater proportion of the accidents involving girls are on main roads, than are accidents involving boys. This is true in each of the study areas. The difference has been shown to be statistically significant ($p<0.005$) by fitting a log linear model with a poisson error structure using the GLIM program (Baker and Nelder, 1978). Appendix A.5 explains the use and exact form of the model used to test the significance of this difference. Reasons for girls having a larger proportion of accidents on main roads than boys could again be either behavioural differences or a sexual variation in the exposure on these types of roads.

3.5.2 The age of the child. Figure 3.6 shows the frequency of child pedestrian accidents by age and sex of the child involved for all five areas.

Figure 3.6: Child pedestrian accidents for all five study areas by age and sex (1979 to 1984)



This shows that although boys have more accidents in total than do girls, this difference is most appreciable between the ages of about 4 and 9 years (in fact, over the age of 9 years there were slightly more accidents in total to girls (154) than to boys (138)). Comparison of the numbers of accidents to boys aged between 4 and 9 years, and of other ages, with the number of accidents to girls in the same age groups shows the difference between 4-9 years and other ages to be highly statistically significant ($p<0.001$) according to the chi-square test. Table 3.1 shows, that although the population of boys in the age group 5 to 9 years is greater than that of girls of the same ages, this difference is nothing like big enough to account for the above variation in accident numbers.

Studies of the exposure of each age and sex group could possibly show why there is such a large difference in accident frequency for the two sexes between the ages of 4 and 9 years. To date work has shown (e.g Routledge et al,1974a,b) that there is little difference in the exposure rates between the sexes for these crucial ages, while on a journey to or from school. However, it has also been shown that when playing the sex differences in exposure are striking (Chapman et al,1980). For all age groups boys used the streets for play purposes more than girls, and this difference was especially pronounced for 8-10 year olds. It is also possible that behavioural influences could play a part in causing this difference in numbers of accidents between the sexes at these particular ages (see Chapter 2 for a discussion of previous work on children's road crossing behaviour).

The spatial distribution of child pedestrian accidents by the age of the child involved is shown for each of the five study areas in Appendix A.6, Figures 1 to 5. When these are considered bearing in mind the road hierarchy of the areas it can be seen that accidents involving older (mainly secondary school) children almost all take place on main roads. For comparison purposes, the distribution of adult pedestrian accidents by the age of the pedestrian involved for each of the 5 study areas are shown in Appendix A.7, Figures 1 to 5. As can be seen there is a very different pattern of locations between these accidents and the child pedestrian accidents, especially those of the younger children. Table 3.8 shows up some of these differences in more detail.

Table 3.8: Accidents on main and other roads by age group and area.

Age group	Area										All areas	
	Bradford		Bristol		Nelson		Reading		Sheffield			
	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent
Pre-school children:												
Main roads	5	21.7	1	11.1	16	45.7	8	61.5	3	30.0	33	36.7
Other roads	18	78.3	8	88.9	19	54.3	5	38.5	7	70.0	57	63.3
Schoolchildren under 11 years:												
Main roads	30	61.2	27	64.3	71	67.6	33	53.2	56	70.9	217	64.4
Other roads	19	38.8	15	35.7	34	32.4	29	46.8	23	29.1	120	35.6
Schoolchildren 11-16 years:												
Main roads	39	76.5	40	90.9	27	71.0	34	82.9	53	77.9	193	79.8
Other roads	12	23.5	4	9.1	11	29.0	7	17.1	15	22.1	49	20.2
Adults(16+):												
Main roads	78	81.3	83	92.3	71	87.7	83	94.3	98	80.3	413	86.6
Other roads	18	18.7	7	6.7	10	12.3	5	5.7	24	19.7	64	13.4

NB. Accidents where the age of the pedestrian was not known were not included in this table.

The table shows that there are differences in the proportions of accidents on main and other roads for the different age groups of pedestrians. These differences have been shown to be statistically highly significant ($p<0.001$) by fitting a log linear model with a poisson error structure using the GLIM program (Baker and Nelder,1978). Appendix A.8 gives further details of this model. The table shows, that for the five areas together, 79.8% of accidents to the older schoolchildren were on main roads. This figure is similar to that of adults (86.6%). This backs up those who argue that older children use a very similar crossing strategy to that of adults (e.g Grayson,1975b). In contrast pre-school children have most of their accidents on other roads, at least for all the five areas together, though there is some variation in the figures for the individual areas. The proportions for Reading appear to be out of line with those for the other areas, but this could be due to chance in view of the very small number of accidents on which they are based. Nelson also has a high proportion of these accidents on main roads, despite the figure being based on a larger number of accidents. This could be to do with the characteristics of the houses and the roads in the area. The predominant form of house in Nelson - the terrace - often has small gardens and leaves nowhere else for small children to play but the immediate roadway outside. Even along many of the main roads in this area, the houses are often of this type, with only a very narrow 'buffer' between the front door and the road.

3.6 The time of occurrence of the accidents

There are various timescales over which the accidents can be compared. Some of these will be covered here.

3.6.1 School holidays versus schooldays. For the purposes of these analyses, the term school holidays will include the major holiday periods at Christmas, Easter and during the Summer, as well as half terms and occasional days (where known). Weekends will be considered separately. Table 3.9 shows the proportions of accidents for each of the five areas which occurred on a schoolday, in each of the different holiday periods and at weekends. It should be noted that in Nelson the pattern of school holidays is slightly different to the other areas. Instead of having one long Summer holiday from the end of July to the beginning of September, their 'Mid summer' holiday starts at the beginning of July and ends in the middle of August. Following this there is a further Autumn holiday for two weeks in September. Accidents in both of these periods have, for the purpose of this analysis, been classified as summer holiday accidents. There is no half term holiday in Nelson in October/November, as in the other areas.

Table 3.9: Accidents to child pedestrians by the period of the school year in which they occurred (all figures except the base are percentages).

Period of year	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Accidents on school holidays (weekdays):						
Christmas	3.3	2.1	2.2	0.9	1.3	1.9
Easter	4.1	2.1	2.8	1.7	4.5	3.1
Summer	8.8	8.4	5.6	5.1	6.4	6.7
Other	4.1	5.3	2.8	5.1	3.2	3.8
All holidays	20.3	17.9	13.5	12.8	15.4	15.5
Accidents at weekends:						
In termtime	16.2	20.0	10.6	16.3	10.8	14.0
During holidays	4.1	10.5	7.9	6.8	6.4	7.0
All weekends	20.3	30.5	18.5	23.1	17.2	21.0
All accidents not on schooldays	40.6	48.4	32.0	35.9	32.6	36.5
All accidents on schooldays	59.4	51.6	68.0	64.1	67.4	63.5
Base	123	95	178	117	157	670

This shows that in terms of absolute numbers of accidents, for all the five areas together most occur on schooldays (63.5%), followed by weekends (21.0%), and then school holidays (15.5%). This relationship is true in all of the areas, except Bradford where the same proportion of accidents occur on weekends as on school holidays.

It should be noted when considering Table 3.9 that there are different numbers of days in each holiday, and often also for the same holidays between areas. These differences are taken into account in Table 3.10, which shows the number of accidents per 100 days of certain of the periods shown in Table 3.9.

Table 3.10: Numbers of accidents to child pedestrians per 100 days of certain periods in the school calendar.

	Area					
	Bradford	Bristol	Nelson	Reading	Sheffield	All areas
Accidents on school holidays:						
Christmas	6.2	2.6	5.9	1.4	3.5	3.8
Easter	8.9	3.3	8.1	2.9	11.7	6.8
Summer	5.9	4.3	4.8	3.2	5.6	4.7
Other	5.1	5.3	5.7	6.3	4.0	5.1
All holidays	6.1	4.2	5.7	3.5	5.7	4.9
Accidents at weekends:						
In termtime	4.8	4.7	4.5	4.8	4.2	4.6
In holidays	2.4	4.4	6.6	3.5	4.6	4.3
All weekends	4.0	4.6	5.2	4.3	4.3	4.5
All accidents not on schooldays	4.8	4.4	5.4	4.0	4.9	4.7
All accidents on schooldays	6.3	4.3	10.7	6.6	9.2	7.4

This shows that in Bristol, unlike the other areas, there are about the same number of accidents per 100 days on school holidays as schooldays. In Bradford, Nelson and Sheffield there were more accidents per hundred days on school holidays than at weekends, while in Bristol and Reading the opposite is the case. In all of the areas apart from Bristol there are more accidents per 100 schooldays than there are on school holidays or weekends.

The table also shows that in total the Christmas holiday period has fewer accidents per day than any of the other holiday periods. This could be due to the amount of time spent indoors on this holiday compared to the others. Apart from schooldays, Easter would appear to be the most dangerous time of the year for child pedestrians, though this figure is very heavily influenced by the Sheffield total which is particularly high at Easter. Perhaps suprisingly there are less accidents than would be expected in the Summer holidays, despite the likely high levels of exposure in this period. However it is possible that these high levels mean that more care is taken by drivers, and that the relative safety of children is thus increased.

3.6.2 Time of day. Figure 3.7 shows accidents to child pedestrians by time of day of occurrence for all the five areas and in total. It can be seen that there are only two accidents to children before 8am and very few after 8pm. These features may reflect two things. Firstly the small number of children on the streets before 8am and after 8pm, and possibly as well, the relatively small number of cars on the streets at the same times.

The second point to notice from the diagram is that almost a half of the accidents occur between the hours of 3 and 6pm (44.7%, 44.2%, 46.6%, 41.0% and 42.7% in Bradford, Bristol, Nelson, Reading and Sheffield respectively). There is also a peak of accidents in the morning between the hours of 8 and 9am, though this is not as noticeable in Bradford, Bristol, and particularly Nelson, as in Reading and Sheffield (6.5%, 8.4%, 2.8%, 18.0% and 15.9% in the five areas respectively). Finally the third peak period for accidents is at lunchtime between the hours of 12 noon and 2pm (10.6%, 19.0%, 15.2%, 7.7% and 10.2% in the five areas respectively). There is some variation in the sizes of the peaks between the areas, though the reasons for this are not known.

Figure 3.7: Child pedestrian accidents by time of day
(1979 to 1984)

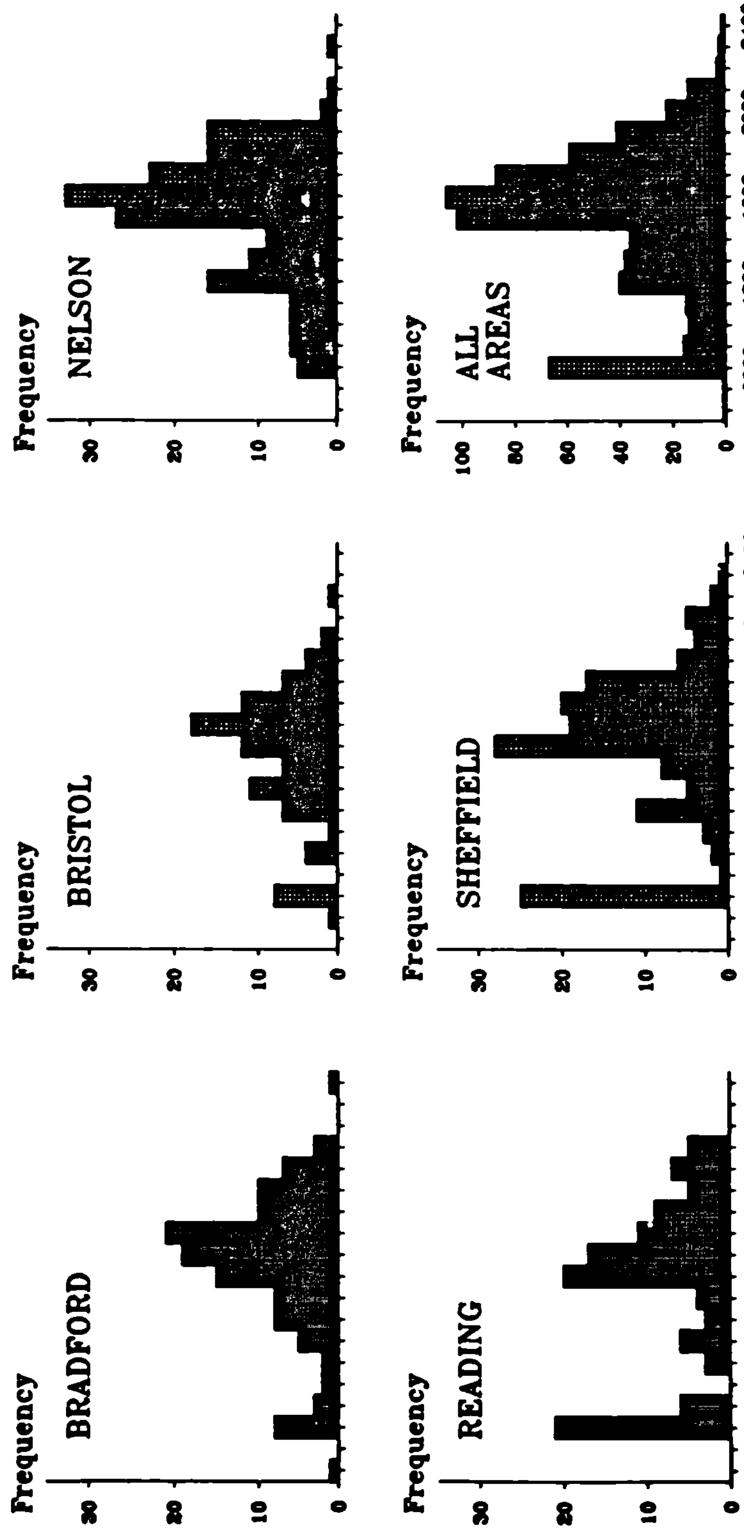
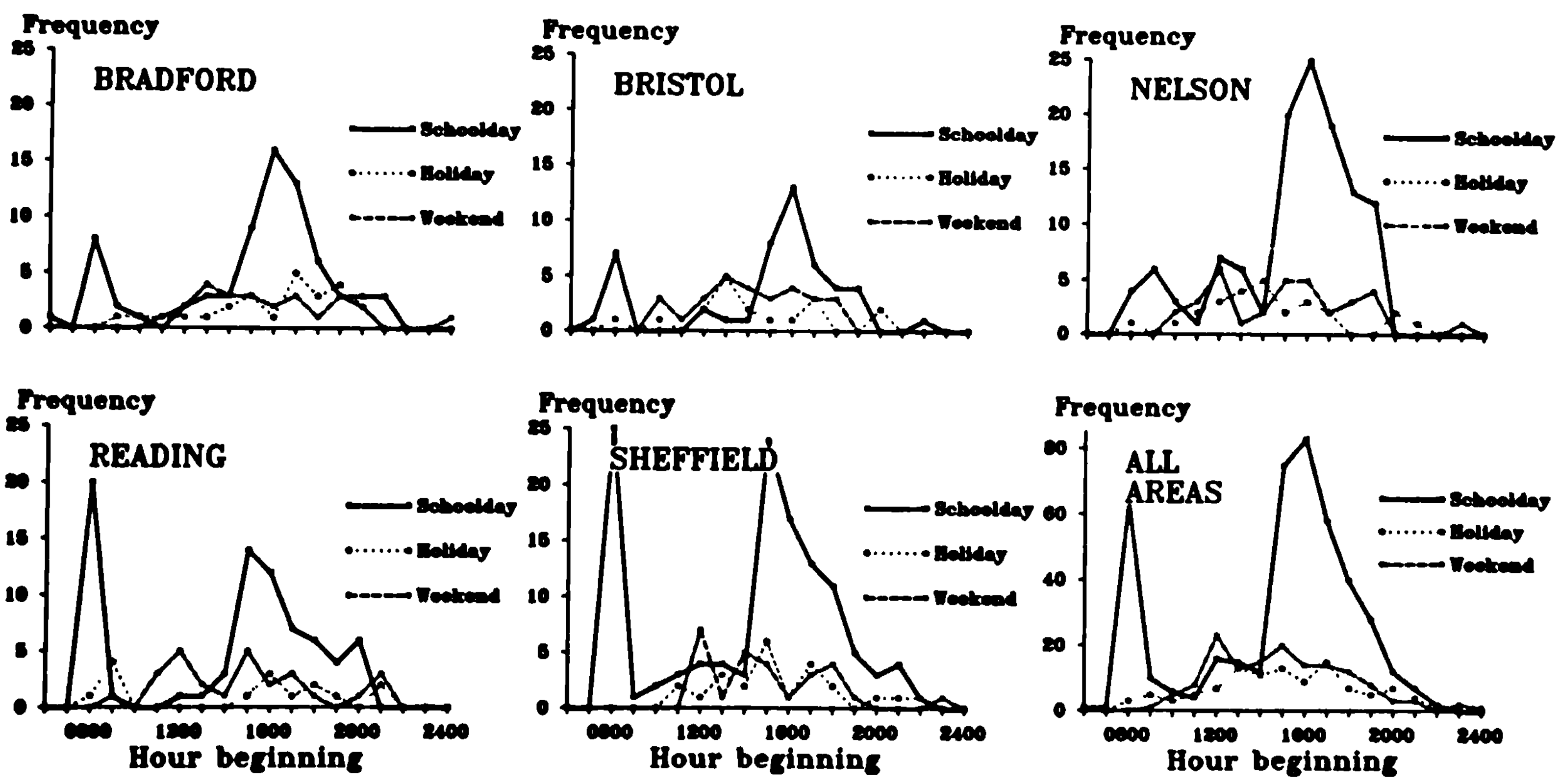


Figure 3.8: Child pedestrian accidents by time of day and school year (1979 to 1984)



A more detailed consideration of accidents by time of day can be made by looking at the times of occurrence of those which happened on a schoolday, compared to those on school holidays and at weekends. Figure 3.8 shows this for each of the five areas, and altogether.

If only those accidents which occurred on schooldays are considered (59.4%, 50.6%, 66.4%, 64.1% and 67.4% in Bradford, Bristol, Nelson, Reading and Sheffield respectively) then the morning and evening peaks become more conspicuous, presumably because it is rare for children (except pre-school children) to be exposed to risk of an accident during school hours. The lunchtime peaks are less obvious on school days except perhaps in Nelson and Sheffield.

All of those accidents that occurred between the hours of 8 and 9am were on a weekday, all but one were on a schoolday (66 out of 67), and most were recorded as being on the journey to school (57 out of 67). This is consistent with travel to school being the main journey purpose that children have at these hours.

Due to the small numbers of accidents on school holidays and on weekends in each of the areas, it is best to consider the pattern for all the areas together. There appear to be no peaks during the day for the school holiday accidents, except perhaps for a small one between 5 and 6pm. Most of the accidents on the school holidays occur after midday, which is probably the time at which a lot of outdoor activity, especially play, takes place. The weekend accidents do appear to have certain peak times of occurrence. The biggest of these peaks is from 12-1pm, and there is a second at about 3pm. Similar peaks were found in another study, one occurring in the early afternoon, and perhaps another less obvious one in the late afternoon

(Wade, Foot and Chapman,1982). Like the school holiday accidents there are very few weekend accidents before midday.

The spatial distributions of child pedestrian accidents in the five areas by the time of day of their occurrence are shown in Appendix A.9, Figures 1 to 5. The afternoon peak of accidents stands out clearly in these maps. Of the times shown, the peak traffic periods (in this case 0700 to 0959 and 1500 to 1759) contain a higher proportion of accidents on main roads than the non-peak periods in all the areas except Sheffield, but according to the chi-squared test this difference could easily have arisen by chance in all of the areas except Bristol, where it is statistically significant at about the 1 percent level. Table 3.11 shows the numbers of children injured on main and other roads at these peak hours, and at other times of the day.

Table 3.11: Child pedestrian accidents at peak and non-peak hours by road type (1979-1984).

Time of day	Area										All areas	
	Bradford		Bristol		Nelson		Reading		Sheffield			
	Main road	Other road	Main road	Other road	Main road	Other road	Main road	Other road	Main road	Other road	Main road	Other road
Peak hours*	43	25	42	9	61	33	51	24	63	30	260	119
Non-peak hours	31	26	26	18	53	31	25	17	49	15	184	107
Total	74	49	68	27	114	64	76	41	112	45	444	226

* For the purposes of this study, peak hours are defined as being from 0700-0959 and 1500-1759.

3.6.3 <u>Daylight and darkness accidents</u>. 'Stats 19' data can be subdivided into those accidents which occurred in darkness, and those that did not. Table 3.12 shows the proportions of accidents occurring in daylight and darkness in the five areas. The definition of 'darkness' used by 'Stats 19' is the period from "half an hour after sunset to half an hour before sunrise" (DTp.,1978).

Table 3.12: Accidents to child pedestrians in the light and dark (all figures except the base are percentages).

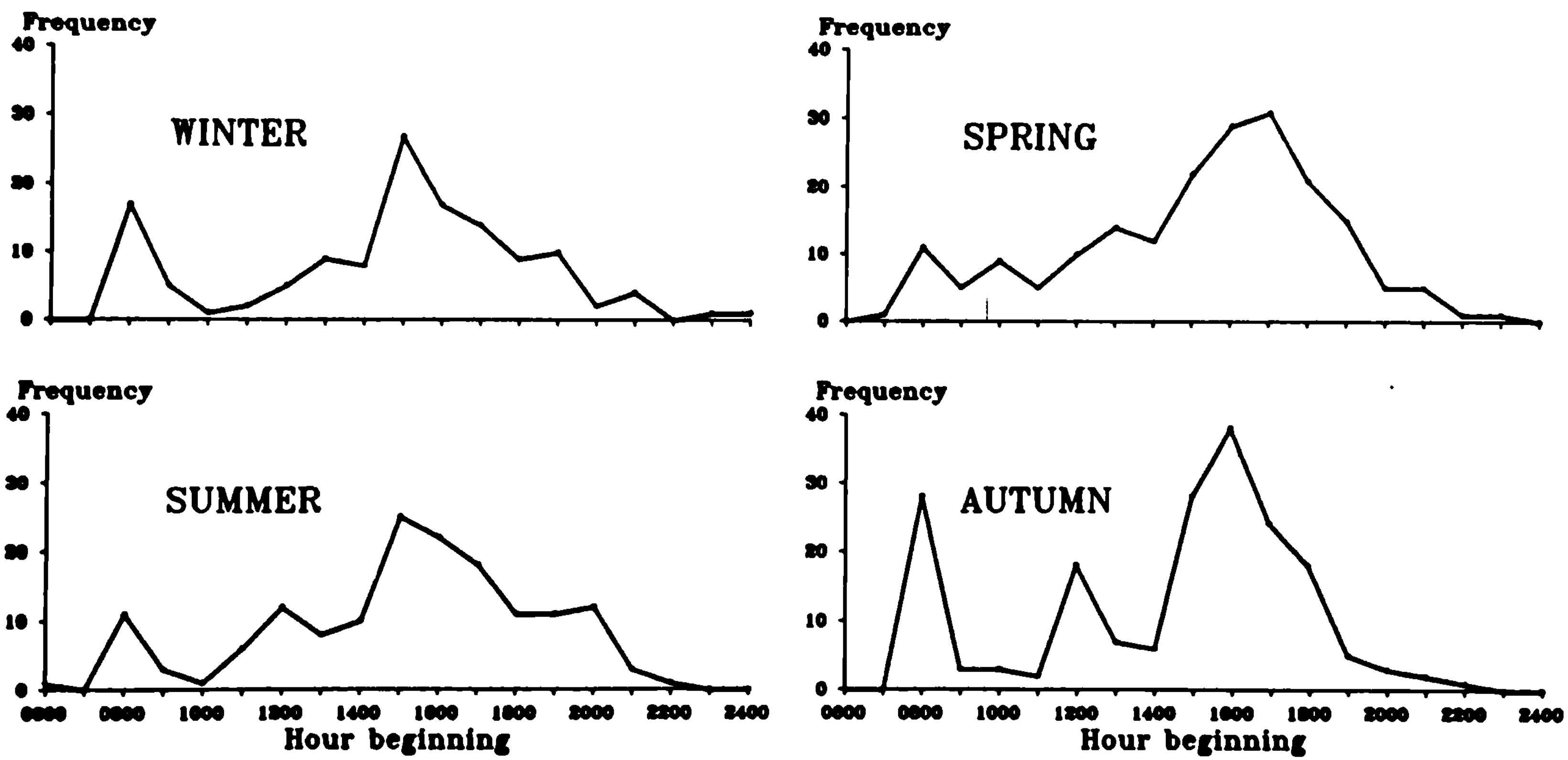
Lighting	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Darkness Daylight	14.6 85.4	15.8 84.2	15.2 84.8	13.7 86.3	17.2 82.8	15.4 84.6
Base	123	95	178	117	157	670

As can be seen only 15.4% of the accidents in total occur in the darkness. Of these 79.6% also occur in the Autumn and Winter. The location of the accidents which occur in darkness are shown in Appendix A.10, Figures 1 to 5. It can be seen from these that in all the 5 areas, accidents in the darkness tend to occur predominantly on the main roads (83.3%, 86.7%, 55.6%, 62.5% and 85.2% in Bradford, Bristol, Nelson, Reading and Sheffield respectively). This is also the case for accidents in daylight, though to a much lesser extent in Bradford, Bristol, and Sheffield (56.2%, 68.8%, and 68.5%). In Nelson and Reading there are higher proportions of accidents on main roads in daylight (65.6% and 65.3%) than on main roads in darkness.

3.6.4 Season of year. For the purposes of this study, the seasons were taken to be Winter (from December 22nd to March 20th), Spring (March 21st to June 21st), Summer (from June 22nd to September 22nd), and Autumn (September 23rd to December 21st). Figure 3.9 shows the frequency of accidents by season of year and time of day. It can be seen from this that more accidents occur in the Autumn and Spring (27.8% and 29.4% respectively) than in the Summer and Winter (23.1% and 19.7% respectively). Also worth noting are the higher percentages of accidents occurring in the Winter and Autumn during the morning peak period between 8 and 9am (2.5% and 4.2% respectively) which are not apparent in the Spring and Summer (1.6% and 1.6% respectively). The most likely factor that this could be due to is the predominance of dark mornings in the Autumn and Winter causing the higher accident rates. However, considering the figures in more detail, it appears that only one of the accidents in the Autumn and Winter morning peaks actually occurs in the darkness. It is possible that other related reasons could play a part, such as adverse weather conditions and poor visibility.

In the Autumn period there are three distinct peaks of accidents during the day. In the Winter there are only two such peaks, one in the morning and one in the evening. In the Spring and Summer there are evening peaks, and some indication of a morning peak, but perhaps also there is a more even spread of accidents throughout the whole day than in the other seasons.

Figure 3.9: Child pedestrian accidents by time of day and season of year for all five study areas (1979 to 1984)



The sharp peak of accidents in the Winter in the afternoon comes earlier in the day than the afternoon peak in the Autumn. Also, the afternoon peaks in the Autumn and Winter are shorter in duration than those in the Summer and Spring. It is noticeable that in the Summer, unlike in the other seasons, there are still a lot of accidents occurring as late as 8pm. This could be related to the likely higher levels of usage of the roads by children on Summer evenings, compared to that in other seasons.

3.7 Journey purpose

The 'Stats 19' form only requires a distinction to be made between those accidents which occurred on a journey to or from school, and those that did not. No other journey purpose is recorded. However, children are also classified by whether or not they are school pupils. Table 3.13 shows the breakdown of the accidents by journey purpose for all five areas. In the Bristol and Nelson areas a smaller proportion of accidents occurred on a journey to or from school (19.0% and 21.3%), than in the other three areas. Reasons for this difference are not yet known, but in the case of Bristol it is consistent with the low proportion of accidents occurring on schooldays (see Table 3.9). Nelson on the other hand has a high proportion of accidents on schooldays (66.4%) but relatively few of these are recorded as actually occurring on the journeys to and from school.

Table 3.13: Accidents by journey purpose and sex of child for all the five areas (all figures except the base are percentages).

Journey purpose and sex	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Accidents to school age children:						
On a journey to or from school:						
Males	17.0	5.3	16.3	16.2	12.1	13.9
Females	9.8	13.7	5.0	17.1	17.2	12.1
Total	26.8	19.0	21.3	33.3	29.3	26.0
Not on a journey to or from school:						
Males	31.7	39.9	34.3	33.4	37.5	35.2
Females	22.8	31.6	23.6	22.2	25.5	24.8
Total	54.5	71.5	57.9	55.6	63.0	60.0
Accidents to pre-school children:						
Males	12.2	5.3	13.5	4.3	2.6	7.9
Females	6.5	4.2	6.2	6.8	3.8	5.5
Total	18.7	9.5	19.7	11.1	6.4	13.4
Unknown	0.0	0.0	1.1	0.0	1.3	0.6
Base	123	95	178	117	157	670

Other studies have estimated the proportion of accidents that happen on the journey to or from school to be between 9 and 33% (Grayson,1975a). The areas used in this study fit into those limits, but it must be borne in mind that some of these other studies take into account accidents occurring in areas dissimilar to the ones used in this study, and where the number of children injured on a journey to or from school is likely to be less. Three of the figures for this study are probably at or near the top of the limits set by the other studies because of the suburban nature of the areas considered.

The distribution of accidents in the five areas that happened on a journey to or from school, on the journey to or from school outside the child's school, and also those that happened during times when most journeys to or from school are being made (i.e 8-9am, 12-2pm, and 3-5pm, on weekdays in school terms, and to school age children), but which are not actually categorised as being on a journey to or from school are shown in Appendix A.11, Figures 1 to 5. What stands out most from these maps is that few accidents actually occur outside the child's school, although this has been commonly cited as a dangerous location in the past (see for instance Preston,1980 or Driscoll and Ashton,1981). In fact only 6.1%, 16.7%, 18.4%, 10.3% and 17.4% of the school journey accidents in Bradford, Bristol, Nelson, Reading and Sheffield actually occurred outside the child's school, which bearing in mind the liklihood of high exposure levels at these points, does not seem unduly high, although it is certainly possible that the high exposure levels could in themselves be part of the reason for the low accident rates.

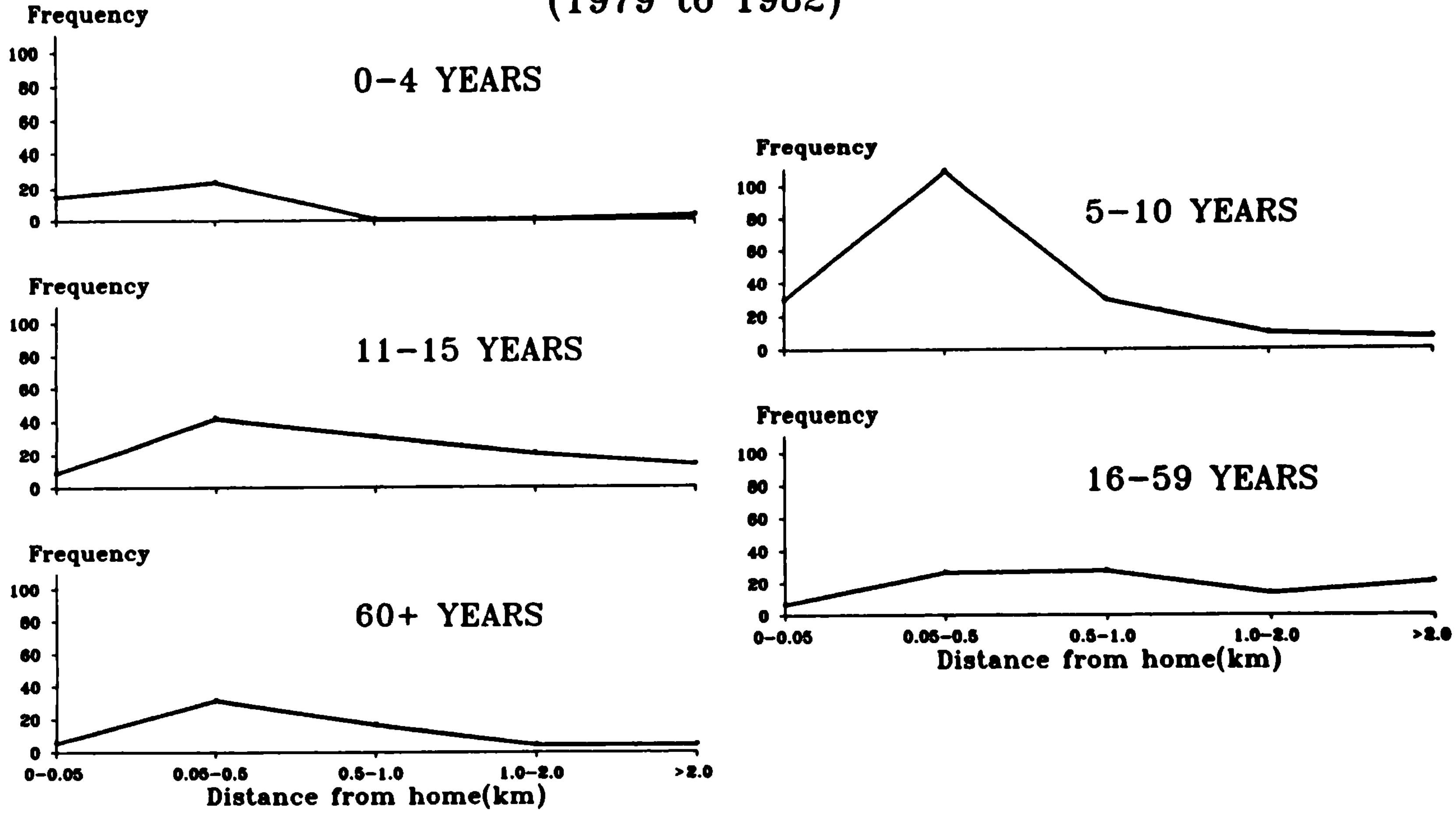
For all the areas together, a larger proportion of accidents to girls (28.5%) occurred on a journey to or from school than accidents to boys (24.3%), however this difference is not statistically significant (χ^2 with one degree of freedom = 1.37, p>0.2).

3.8 Location of the accidents

Previous figures have already shown the exact location of the accidents in the areas. These locations will now be discussed in more detail, in relation to their distance from the home of the pedestrian involved, to their occurrence at junctions and crossing facilities, and finally in the vicinity of parked vehicles.

3.8.1 Distance from home. The address of the pedestrian involved in each accident was obtained from police accident reports for each of the five areas, and then the shortest road distance from this point to the accident site was measured (this has only been done for accidents in the years 1979-1982). Figure 3.10 shows these distances by the age of the pedestrian involved for all the areas together. As can be seen, both 0-4 year olds and 5-10 year olds have most of their accidents near to their homes. Children in the age group 11-15 years have a larger proportion of accidents further from home. The diagram for this age group is similar to that of the adults aged between 16 and 59. Finally for the 60+ age group the majority of the accidents are again nearer to home. Similar results were found in a study in Hampshire, where most children who were knocked down were within a quarter of a mile of their home, though this proportion was found to be less, the older the children were (Grayson,1975a). The diagrams in Figure 3.10 must to some extent be representative of the relative mobility of the different age groups.

Figure 3.10: Pedestrian accidents by distance from home and age for all five study areas (1979 to 1982)



3.8.2 Junction type. Table 3.14 shows the proportions of accidents occurring at different types of junctions in each of the five areas.

Table 3.14: Accidents by junction type for the five areas (all figures except the base are percentages).

	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Roundabout	1.6	2.1	0.0	2.6	0.6	1.2
'T' or staggered junction	47.2	36.8	40.4	35.0	35.7	39.1
'Y' junction	2.4	0.0	0.6	0.0	1.9	1.0
Crossroads	9.8	23.2	26.4	2.6	9.6	14.8
Multiple junction	2.4	0.0	0.6	0.0	0.6	0.8
Private drive	0.0	1.1	0.0	0.9	0.0	0.3
Slip road	0.8	0.0	0.0	0.0	0.0	0.2
Other junction	5.7	0.0	4.5	2.6	3.2	3.4
Total at or within 20 metres of a junction	69.9	63.2	72.5	43.7	51.6	60.8
Total not at or within 20 metres of a junction	30.1	36.8	27.5	56.3	48.4	39.2
Base	123	95	178	117	157	670

In this table some of the differences between the areas can be explained to some extent by the variation in the numbers of particular junction types in each area. For instance, there are a lot of accidents in Nelson at crossroads, which are a commoner junction type there than in the other areas. The table shows that about 40% of the accidents in the five areas put together occur 'not at or within 20 metres' of a junction, and about another 40% of the accidents happened at a 'T' or a staggered junction. Analysis of Stats 19 data for the whole of Great Britain for 1975 in the Transport Studies Group showed that in this year about half the accidents to child pedestrians (0-16 years) occurred not at a junction, and about another third occurred at a 'T or staggerred' junction. Both of these figures, and those for the study areas, seem to imply that junction locations, especially T or staggerred junctions, which make up only a small proportion of the road network, are more dangerous places to cross the road than locations away from junctions, which make up the vast majority of the road network. Unfortunately it is not known for the study areas, or for the national road network, what proportion of road crossings by children occur away from junctions, and the proportion which occur at junctions. It is possible that non-junction locations may in fact be more dangerous if they are used much less often than junction locations (see Grayson, 1981 for further discussion of this point).

Analysis of the accident data by junction type and age of child shows a greater proportion of accidents at junctions for older secondary school age children than for younger children, but this difference could easily have arisen by chance (χ^2 with one degree of freedom = 1.02, p>0.30).

3.8.3 <u>Type of crossing facility</u>. Table 3.15 shows the occurrence of child pedestrian accidents at crossing facilities for each of the five areas, and in total.

Table 3.15: Accidents at crossing facilities for each area (all figures except the base are percentages).

Type of crossing	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
No crossing within 50 metres	90.3	72.6	93.8	77.7	84.6	85.2
Zebra crossing	5.7(7)	22.1(13)	0.6(1)	8.6(12)	1.3(1)	6.1
Pelican crossing	1.6(1)	0.0(2)	4.5(6)	11.1(10)	11.5(7)	6.1
School crossing patrol	2.4(19)	0.0(8)	1.1(11)	0.0(16)	2.6(16)	1.3
Footbridge or subway	0.0(0)	2.1(1)	0.0(0)	0.0(0)	0.0(0)	0.3
Other	0.0	3.2	0.0	2.6	0.0	0.5
Base	123	95	178	117	157	670

Figures in brackets give the number of each particular type of crossing facility in the areas.

This shows that the majority of the accidents happen more than fifty metres away from any sort of crossing facility (85.2%). Appreciable numbers also occur on Zebra and Pelican crossings, especially in those areas where these types of crossings are most common. Again there are problems in interpreting this data as the exposure of children on crossings and away from them is not known. Nationally, 87.0% of child pedestrian accidents occur more than 50 metres away from crossing facilities of any sort (DTp.,1984).

3.8.4 Involvement of parked vehicles. Table 3.16 shows the proportions of child pedestrian accidents that involved a child masked by a parked vehicle.

Table 3.16: Accidents where a child was masked by a parked vehicle (all figures except the base are percentages).

	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Masked	26.8	35.8	29.2	33.3	30.6	30.8
Not masked	73.2	64.2	70.8	66.7	69.4	69.2
Base	123	95	178	117	157	670

This shows that about a third of the accidents involved a child being masked to some degree by a parked vehicle. Although there are some differences between the areas, these are not statistically significant. Nationally 30.6% of road accidents to child pedestrians aged 14 years and under involved a parked vehicle (DTp.,1984).

It might be thought that younger children would have more accidents in which a parked vehicle was involved than older children, because their smaller size would mean they are less visible to drivers and also have less chance of seeing an approaching vehicle over the top of a parked vehicle. However, various chi square tests have shown that differences between the proportions of children masked by a parked vehicle for various age groups are not statistically significant.

The spatial distribution of the accidents in which a child was masked by a parked vehicle for each of the five areas is shown in Appendix A.12, Figures 1 to 5. A more detailed look at the figures shows that a much smaller proportion of the accidents on main roads involved parked vehicles than accidents on other roads. This difference can be shown to be highly statistically significant (χ^2

with one degree of freedom = 20.4, $p<0.001$). This is perhaps to be expected as in most cases there are likely to be less parked vehicles and more likelihood of accidents of other kinds on main, than on other roads.

3.9 Others involved in the accidents

Table 3.17 gives a breakdown of the accidents for the five areas by the type of other vehicle involved.

Table 3.17: The colliding vehicle (all figures except the base are percentages).

Vehicle type	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Bicycle	0.0	0.0	1.1	0.0	0.0	0.3
Moped	0.0	4.2	1.7	0.9	1.9	1.6
Motorscooter	1.6	0.0	0.0	0.0	0.0	0.3
Motorcycle	8.1	9.5	2.3	5.1	6.4	5.8
Invalid tricycle	0.0	0.0	0.0	1.7	0.0	0.3
Other 3-wheeler	3.3	1.1	0.6	0.0	0.0	0.9
Taxi	0.0	1.1	0.6	0.0	1.3	0.6
Car(4 wheels)	78.9	83.0	79.6	82.0	85.9	81.9
Minibus	0.0	0.0	0.6	0.0	0.0	0.2
PSV	2.4	0.0	0.6	0.9	1.9	1.2
Goods(<1.5 ton)	5.7	1.1	11.2	6.8	1.3	5.7
Goods(>1.5 ton)	0.0	0.0	1.1	0.0	1.3	0.6
Other motor vehicle	0.0	0.0	0.6	2.6	0.0	0.6
Base	123	95	178	117	157	670

As one might expect, the majority of the child pedestrian accidents involved a single car (4 wheeled) hitting the child. Nationally, 75.1% of accidents to all pedestrians involved a 4 wheeled car (DTp.,1984). The difference between this and the figure for the study areas (81.9%) could be due to goods vehicles being underrepresented in the study areas due to the small number of main roads they contain (7.9% of all pedestrian accidents nationally involved goods vehicles, while in the study areas only 6.3% do). Similarly motorcycles are also underrepresented (9.5% nationally and 7.7% in this study), as are bicycles (1.3% nationally and 0.3% in this study).

As well as the vehicle that hit the child, information is also available on the driver of that vehicle. This comes in two forms, the sex of the driver and their age. Table 3.18 shows the sex of the drivers involved in the accidents for each of the areas for drivers under 35 and 35 or over separately.

Table 3.18: Age and sex of the driver of the other vehicle involved (all figures except the base are percentages).

Age and sex	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Under 35 years:						
Males	42.3	44.2	45.5	38.5	44.6	43.3
Females	7.3	11.6	9.6	6.8	7.0	8.4
Total	49.6	55.8	55.1	45.3	51.6	51.7
35 years and over:						
Males	39.0	34.7	36.5	35.9	35.7	36.4
Females	9.8	9.5	6.7	11.1	7.0	8.5
Total	48.8	44.2	43.2	47.0	42.7	44.9
Unknown	1.6	0.0	1.7	7.7	5.7	3.4
Base	123	95	178	117	157	670

This shows that by far the majority of the drivers involved in the accidents in all the areas are male. National figures for the sex of drivers involved in all sorts of road accidents are very similar, with 77.7% involving males, 17.9% involving females and 4.4% unknown (DTp.,1984).

The table also shows that drivers below the age of 35 are involved in more than half of the accidents to child pedestrians in the study areas together. This is also true nationally. Males aged 35 and over account for a lesser proportion of the accidents in the study areas, in relation to females in the same age group than males under 35 years. This difference could easily have arisen by chance (χ^2 with one degree of freedom = 0.85, p>0.30) but it is consistent with a finding of Satterthwaite (1976) who showed that in 1972/3 males aged 17 to under 35 had on average 0.80 accidents with all ages of pedestrian, per million miles driven in Great Britain and men aged 35 and over had 0.35, while women under 35 had 0.68 and women aged 35 and over had 0.38. These relationships will depend to a great extent on the usage of cars by the different age groups and sexes and also on their varying levels of ownership of vehicles, and driving experience.

3.10 The child's behaviour

Data from 'Stats 19' concerning the child's behaviour just prior to his or her accident is severely limited. Only two variables provide any idea of this. These are firstly the child's movement at the time of the accident, and secondly the short description that is given with each accident.

3.10.1 The child's movement. Table 3.19 shows the child's movement at the time of the accident for each of the areas separately and in total.

Table 3.19: The child's movement, by area (all figures except the base are percentages).

Movement	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Crossing from the driver's nearside	64.2	58.9	58.4	59.9	63.7	61.1
Crossing from the driver's offside	26.0	36.8	34.3	23.9	31.2	30.6
In carriageway not crossing(standing or playing)	4.1	3.2	1.7	11.1	3.2	4.3
Walking along facing traffic	0.8	0.0	2.8	3.4	0.0	1.5
Walking along back to traffic	3.3	1.1	1.7	1.7	0.6	1.6
Unknown	1.6	0.0	1.1	0.0	1.3	0.9
Base	123	95	178	117	157	670

This shows that for all the five areas the most common movement of the child before the accident was trying to cross the road (91.7%). Nationally, 91.0% of children under 14 years were trying to cross the road when the accident occurred (DTp.,1984). The majority of the children in this study were trying to cross the road from the driver's nearside. This is perhaps to be expected as this manoeuvre usually leaves the driver less time to see the child and thus to take avoiding action than when the crossing is from the driver's offside. One might also expect that because of this the nearside crossing accidents would tend to be more serious. Table 3.20 shows the numbers of accidents of different severities by the movement of the child prior to the accident. Serious and fatal accidents are considered together in this analysis due to the small number of fatal accidents.

Table 3.20: Severity of accident by action of child (using data for all 5 areas).

Action	Severity		Total
	Slight	Fatal and serious	
Crossing from the driver's nearside	295	114	409
Crossing from the driver's offside	149	56	205
Other	44	12	56
Total	488	182	670

It can be seen that there is no significant difference between the proportions of accidents of each severity involving children crossing from the nearside, and those crossing from the offside. Thus, the severity of an injury to a child pedestrian does not appear to be related to the side of the road from which they were crossing.

Compared to the other areas, there are a surprisingly large group of children in Reading who were described as being "in the carriageway, not crossing (standing or playing)" at the time of their accident. The reasons for this are not known.

3.10.2 Road accident descriptions. Table 3.21 provides a subjective breakdown of the descriptions given by the police officer present, of the accident. This shows that child pedestrian accidents are generally categorised by as few as four or five expressions (all but 5.1% of the descriptions can be included under these headings). The table picks out certain key words of these expressions.

Table 3.21: Accident descriptions containing certain keywords or phrases (all figures except the base are percentages).

Description	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Walked/stepped into the road	10.6	3.2	11.8	9.4	12.1	10.0
Ran into the road	48.8	47.3	67.0	52.2	70.1	58.9
Crossed the road	18.7	33.7	12.4	23.9	6.4	17.2
Driver at fault	12.2	10.5	4.5	5.1	8.9	7.9
Other description	8.1	5.3	2.8	9.4	1.9	5.1
No description	1.6	0.0	1.7	0.0	0.6	0.9
Base	123	95	178	117	157	670

As can be seen most children were described as running into the road, and thus by implication are blamed for the accident. In as little as 7.9% of the cases did the police officer explicitly describe the driver as being at fault, though there may be other cases in which the driver was wholely or partly to blame. Variations in the figures between areas may reflect diffe ent ways of reporting, or different phrases in common usage by the reporting officers. The fact that so many children are said to have run into the road may possibly reflect a bias towards the driver's view of the accident. Similar analyses in the Federal Republic of Germany looked at erroneous behaviour, as reported in police statistics (Schulte,1973- taken from Sandels,1974). It was shown that in this respect children were to blame for 72% of the accidents involving them in the province investigated. Among the two year olds who were starting to manage on their own in traffic, 62% were blamed for the accident in which they were involved (for further discussion of accident responsibility see Howarth and Repetto-Wright,1978, Howarth and Lightburn,1981 or Howarth and Gunn,1982).

A commonly thought of accident situation is a child running out from between parked vehicles, giving the driver little time to stop. Table 3.22 shows the number of accidents in which a child was described as running by whether or not a parked vehicle was involved.

Table 3.22: The child's movement at the time of the accident by parked vehicle involvement (figures for all 5 areas).

	Running	Not running	Total
Child masked by parked vehicle	143	63	206
Child not masked by parked vehicle	252	212	464
Total	395	275	670

The table shows that a greater proportion of children who were in an accident involving a parked vehicle were running, than were not running, compared to children who were in an accident not involving a parked vehicle. This difference has been shown to be highly statistically significant (χ^2 with one degree of freedom = 13.5, $p<0.001$).

Further information on the child's behaviour prior to an accident is not available from 'Stats 19' records. However several other studies (e.g. Grayson,1975b, Finlayson,1972, Van Der Molen,1977, and Older and Grayson,1974) have attempted to provide some indication of this by looking at the normal behaviour of children on the road, and trying to identify any deficiencies in this that may lead to potential conflict situations.

3.11 The behaviour of the others involved in the accidents

Again there are a limited number of measures available in the 'Stats 19' printouts that give any indication of the behaviour of the driver prior to the accident. The most relevant here is the movement of the vehicle. Table 3.23 shows the frequency of each type of movement for each of the five areas and also for the five together.

Table 3.23: Vehicle movement at the time of the accident, by area (all figures except the base are percentages).

Movement	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Reversing	0.8	1.1	2.3	1.7	1.3	1.5
Parked	0.8	0.0	0.0	0.9	0.0	0.3
Waiting to go ahead but held up	0.0	0.0	0.0	1.7	0.6	0.5
Stopping	2.4	2.1	0.6	0.0	1.9	1.3
Starting	1.6	0.0	0.0	0.9	0.6	0.6
U-turn	0.0	0.0	0.0	0.9	0.0	0.2
Turning left	2.4	0.0	1.1	2.6	0.0	1.2
Waiting to turn left	0.8	0.0	0.0	0.0	0.0	0.2
Turning right	0.8	1.1	0.0	0.9	1.9	0.9
Waiting to turn right	0.0	0.0	0.6	0.0	0.0	0.2
Changing lane to left	0.0	0.0	0.0	0.0	0.0	0.0
Changing lane to right	0.0	0.0	0.6	0.0	0.0	0.2
Overtaking moving vehicle on its offside	0.0	1.1	0.0	0.0	0.0	0.2
Overtaking stationary vehicle on its offside	18.7	5.3	10.1	8.6	16.6	12.2
Overtaking on nearside	0.0	0.0	2.8	0.9	2.6	1.5
Going ahead left hand bend	3.3	1.1	0.0	0.9	1.9	1.3
Going ahead right hand bend	0.0	2.1	0.0	1.7	1.9	1.0
Going ahead other	68.4	86.1	81.9	78.3	70.7	76.7
Base	123	95	178	117	157	670

This shows that 76.7% of the accidents in the five areas together, occurred when the colliding vehicle was described as 'going ahead other'. A further 12.2% occurred when the vehicle was overtaking on the offside of a stationary vehicle. Taken with the movements of the children, as indicated in Table 3.19, the vehicle movements in Table 3.23 suggest that most accidents to child pedestrians in these areas occur when a vehicle (usually a car) is driving along in a normal manner and a child enters the carriageway intent on crossing the road, quite often coming out from between parked or stationary vehicles.

Research has shown that drivers do not always anticipate a situation fully, and that in most cases it is the pedestrian who has to take action to avoid a potential accident (Howarth and Lightburn,1980). The figures above indicate that most accidents happen in 'normal' driving circumstances and, it could therefore be construed, are at least in part the result of inconsiderate behaviour on the part of the driver, and a poor understanding of potential accident situations.

3.12 The result of the accident

'Stats 19' datasets provide three categories for the severity of the injury. These are 'slight', 'serious' and 'fatal' (see Appendix A.13 for a more detailed definition). It is very difficult to generalise about the extent of the resultant injuries in any accident as these will depend upon a great many things, not least luck! However two of the main factors that may play a part in determining the extent of the injuries are the speed of travel and size of the colliding vehicle. In this connection, maps have been drawn for all the areas showing the distribution of accidents by the severity of the injury (Appendix A.14, Figures 1 to 5). If these are compared to the road hierarchy for each of the areas, there is an indication of a correlation between the more serious and fatal accidents and the main roads of the areas, where it is likely that speeds will be higher, and size of the vehicles in general greater, than on other roads. To highlight this, Table 3.24 shows the proportions of serious and fatal, and slight accidents that happened on main roads in each of the five areas. Serious and fatal accidents are considered together because of the small numbers of fatal accidents.

Table 3.24: Proportions of accidents of each severity on main roads and other roads, by area.

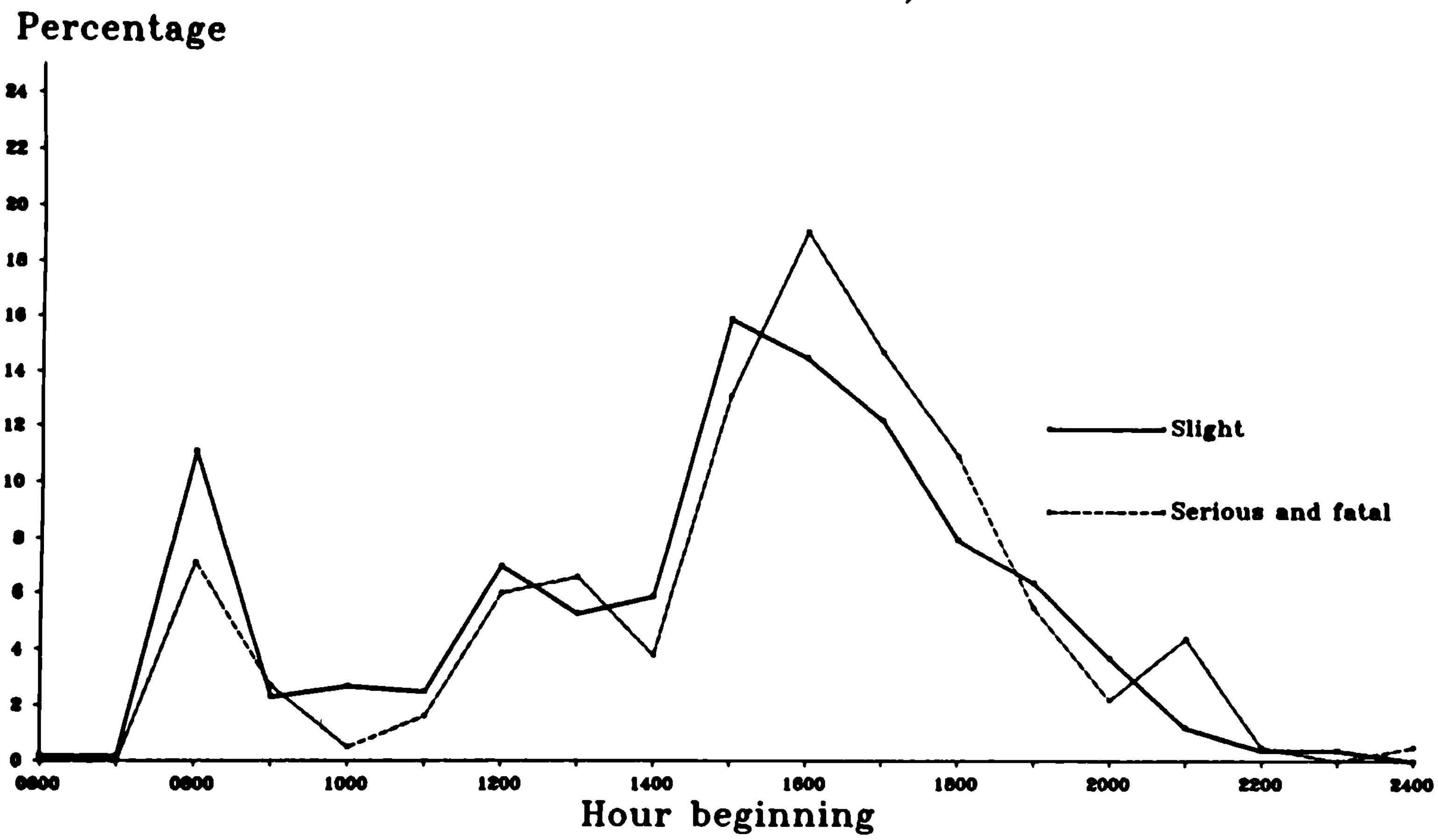
Severity	Area										All areas	
	Bradford		Bristol		Nelson		Reading		Sheffield			
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Fatal or serious												
Main road	21	65.6	21	84.0	28	75.7	28	66.7	34	73.9	132	72.5
Other road	11	34.4	4	16.0	9	24.3	14	33.3	12	26.1	50	27.5
Slight												
Main road	53	58.2	47	67.1	86	61.0	48	64.0	78	70.3	312	63.9
Other road	38	41.8	23	32.9	55	39.0	27	36.0	33	29.7	176	36.1

The table shows that for all the areas a greater proportion of serious and fatal accidents occur on the main roads than slight accidents. This difference has been shown to be statistically significant ($p<0.04$), by fitting a log linear model with a poisson error structure using the GLIM program (Baker and Nelder,1978). See Appendix A.15 for more details of the model used.

There is a no indication in the data that larger vehicles result in more serious child pedestrian injuries. The ratio of serious and fatal accidents to slight accidents for two wheeled vehicles and child pedestrian accidents is 0.38, for cars with child pedestrians it is 0.37, and for all vehicles larger than normal cars with child pedestrians it is 0.38.

A further point concerning the result of an accident comes to light if its severity is considered in terms of the time of day of its occurrence. Figure 3.11 shows this relationship. From this, it can be seen that for most of the day the graph of the proportions of the serious and fatal accidents follows very well the graph of the proportions of the slight accidents, except that in the morning there are slightly smaller proportions of the serious accidents than of the slight, while in the evening the reverse is the case. This difference is consistent with the drivers or the children making bigger, more serious mistakes in the afternoon period than in the morning. If the proportions of serious and fatal and slight accidents occurring during the hour beginning 8am are compared with those between the hours beginning 3pm to 6pm, there is some indication that the difference is statistically significant (χ^2 with one degree of freedom = 3.1, $p<0.08$).

Figure 3.11: Child pedestrian accidents for all five study areas by severity and time of day (1979 to 1984)



3.13 Conclusion

This chapter has shown that accidents to child pedestrians for a six year period in the five areas chosen have happened at particular times, to particular kinds of people, at particular kinds of places and in particular ways. Without considering the exposure of the children on the roads concerned, only limited conclusions can be drawn which can be used as an aid to the design, installation and evaluation of preventive measures. However, further research carried out subsequently to these analyses, which will be discussed in the following chapters, examines in more detail children's activity and exposure patterns in the study areas. From this a more accurate idea of the risk of accidents to particular kinds of children, at particular kinds of places and at particular times is gained.

CHAPTER 4

EXPOSURE DATA COLLECTION METHODS

As a result of the findings of the accident analyses described in Chapter 3, and after a consideration of other work carried out in the road accident field (covered in Chapter 2), it was decided that a useful further study would be to examine, in detail, the exposure of children to risk of a road accident on the road systems of each of the 5 study areas. This would help firstly to increase our knowledge in an area of exposure studies where only limited previous work has been carried out and in which the results to date, partly because of this, have been largely inconclusive. Secondly, it would help to answer some of the questions that have been raised by the accident analyses but which could not be answered because of lack of information about the amount of use made of the road system by various groups of children.

The methods used to collect exposure data in this study were developed with several factors in mind. These included the form, applicability and success of previous exposure studies, the type of analyses for which the exposure data were required, advice from other interested parties, and the amount of time and money that was available to carry out the work.

In areas that are largely residential, children's use of the roads can be roughly split into three groups on the basis of purpose. These are journeys that involve running some sort of errand, such as to the shops. Secondly, there is the use of the roads by children when playing or for recreation. This includes their use of the roads for non-journey purposes, such as playing games in the street, and also making journeys to particular destinations such as to a friend's house. Finally there are those journeys that are related to compulsory attendance at school, and which are made at least twice a day in term time.

Although it was recognised that data should ideally be collected separately for each of these types of use of the roads, it was in fact decided to combine them into only two groups. These were firstly use of the roads related to school attendance and secondly, all other uses of the roads. The main reason for this choice was that 'Stats 19' data on accidents can be split into only two categories of use of the road. These are accidents on a journey to or from school, and accidents which occurred during all other types of use of the roads. Because of this it was considered appropriate, both in terms of analysis, and in terms of collecting the information from children, to treat these categories separately. It would also be difficult to distinguish between use of the roads for recreational journeys and errand type journeys in an exposure study.

Due to the nature of these journey types, it was considered that exposure data should be collected in a different way for each of them. The journeys to and from school are a regular occurrence, taking place at least twice a day in term time, and so the characteristics of these journeys are likely to be easily remembered by children. It was thought therefore that these characteristics could be reliably obtained from children by use of a questionnaire. This would not be the case when considering other types of use of the road, especially for play purposes. These are likely to be much less regular, and will probably have a random element to them, especially in terms of road crossing. It is unlikely therefore, that children questioned about these less regular uses of the road will remember as much about them as they would about the journeys to and from school. Thus, in the case of 'other uses of the road' it was considered that some method of exposure data collection using direct observation would be more suitable.

A detailed description of the method used to collect data concerning the journeys to and from school is given in Chapter 5, and of the method used to collect data on other uses of the roads in Chapter 7.

CHAPTER 5

QUESTIONNAIRE SURVEYS OF CHILDREN'S JOURNEYS TO AND FROM SCHOOL: AIMS AND METHOD

5.1 Aims

So that the results would be compatible with the accident data analysed in Chapter 3, and would also be of sufficient detail to enable appreciable additions to be made to existing knowledge, it was decided that the questionnaire should be designed so that at least the following information about journeys made by children to and from school in each of the areas could be derived:

1. Personal characteristics of the children involved.
   a. Age of child.
   b. Sex of child.

2. School characteristics
   a. The name of the school attended.
   b. The type of school attended.
   c. The child's year and class in school.

3. Journey characteristics.

a. Road where child lives.

b. Mode of travel.

c. Time taken and distance travelled.

d. Exact route of journeys, including the names of all the roads crossed on foot, and the approximate location of each crossing point.

e. The date of the journeys.

One further aim was to provide some form of feedback of the results of the surveys to the schools involved.

It was necessary to collect data from all school age children up to the 5th form in secondary schools, so that the full range of accidents to schoolchildren analysed in Chapter 3 could be related to this data. Thus the questionnaire had to be of a form which could be answered by children of varying abilities throughout this agespan. It was thought best, and indeed easiest to administer the questionnaire in schooltime, usually during regular lessons or tutor periods. Supervision by teachers would mean that the response rate would be high and that help could be given to those children who had difficulty in answering any questions.

5.2 The Sample

It would not have been practical to question every child in each school in the study areas about their school journeys, and so a basis upon which to sample this population of children had to be devised.

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5.2.1 Definition of sample. It was considered necessary to take a sample of children which conformed to two basic requirements. Firstly, it had to be large enough to permit future breakdowns of the data by variables such as age, sex and mode of travel, so that the results from analyses of these reduced samples would still be statistically viable. Secondly, to maximise the coverage of the analysis, it was necessary to obtain roughly equal numbers of each age and sex group involved. To achieve this it was decided to take a stratified sample, structured so that one class from each year group in each school was questioned. It was assumed that each class in mixed schools would contain roughly equal numbers of boys and girls.

In addition, it was considered that the sample should contain a representative set of children of varying abilities and backgrounds. To obtain this it was necessary to ask the schools to complete the questionnaire in a lesson where the children were not split up on the basis of ability. This was more important in the secondary schools, where streaming of some sort is very common, at least for certain subjects. Because tutor groups normally contain children of mixed ability, it was suggested to the secondary schools that a tutor group period might be the best time to complete the questionnaire. It would take at most half an hour to complete, and in a tutor period, would not impinge upon other necessary work. In the primary schools the position was slightly easier as they are generally not streamed, and the class remains with one teacher for the whole day. Research has also shown that road safety as the basis for part or all of a lesson is generally better received in primary schools (Sheppard,1976).

Because children who attend a school in one of the study areas may live outside that area (and so their whole journey is not within that area), and also children who live in a study area may attend a school outside that area, some way of defining which children to sample (and which schools) so that the results could be more easily related to the accident data, which was only pertinent to the study areas, had to be devised. It was decided that the questionnaire should examine a sample of journeys made to schools within the areas. Journeys made from within the areas to schools outside were not considered, though journeys from outside the areas to schools within were included. This meant that the sample was easily defined and that only schools within the study areas needed to be approached about including their children in the survey. The journeys of children travelling from outside the study area to schools within, could be split so that only the section travelled within the study area was included in the exposure analyses. Accident data could be identified to particular schools, with a reasonable degree of certainty, and so children who had accidents within the study areas, on a journey to or from school, but who attended a school outside these areas could be excluded from the analyses of accidents in relation to exposure. In this way the accident and exposure data sets were made compatible.

The questionnaire took a 'snapshot' view of children's journeys to and from school. Children were asked about what they did on their last journey to school (on the morning of the questionnaire), and their last journey home (the night before), rather than what they did usually. It is thought that the former question leads to more accurate answers than the latter, as the last journey is fresher in their memory. This also prevents confusion about what is the 'usual' route. Some children would be questioned by chance on a day when their journey characteristics happened to be very different from normal, but this would reflect a real feature of travel to and from school.

5.2.2 The method of obtaining the sample. In order to implement the questionnaire survey it was necessary to contact all of the schools within the areas, and persuade the headteachers of the value of such a survey. It was considered that personal contact would produce a limited response, because similar individual requests for help are frequent and time consuming for staff, and therefore the enthusiasm of schools for 'yet another survey' is perhaps waning. As a result of contacts that had been made through the linked project, however, it was possible to ask the local Road Safety Officers for the towns, who had good working relationships with the schools in each of the areas, to approach the headteachers on the author's behalf. In four of the areas the Road Safety Officers agreed to help directly, while in the fifth (Nelson), contact with the Road Safety Officer led to the Education Department, who were able to intervene in a similar manner. In this way contact was made with every school in each of the study areas. In three of the study areas, all of the schools agreed to carry out the survey. In the other two areas (Nelson and Sheffield), several schools for various reasons declined to do so. In total 110 out of 122 schools have provided replies to the questionnaires (see Appendix B.1).

From some of the schools which responded to the questionnaire a complete sample was not obtained. For instance in Bradford, only a few replies were received from children in the 1st and 2nd years of first schools, possibly because of difficulties with the questionnaire. In Nelson junior schools only 1st and 4th years replied due to a misunderstanding, so no intermediate year data was obtained. It is thought that this will not have affected the analysis too seriously as the highest and lowest years were obtained, and so the likely extremes will be present in the data. In most secondary schools 5th forms did not reply due to 'pressure of exams'.

5.3 The questionnaires

It was decided to use two questionnaires, one for primary school children and one for secondary school children to make some allowances for the differences in ability between these two groups. Examples of the two questionnaires used are given in Appendices B.2 and B.3. The primary school questionnaire was set out in a simplified form, and included pictorial aids to help the children understand what was wanted. The secondary school questionnaire was more formal, and in some places more detailed. Each consists of four sides of A4 paper. In three of the areas, the questionnaires were printed and produced by the Local Authority, using their own printing methods, while in the other two areas printing was carried out at University College, and then the questionnaires were given to the Local Authorities to distribute. It was noticeable that the questionnaires seemed to be received best by the children and teachers if they were printed on one piece of A3 paper, and then folded as a booklet. This prevented the problem of two pieces of A4 paper becoming detatched, or otherwise lost and mixed up. 'A3 booklets' were used for the Bradford, Bristol and Sheffield surveys.

The questionnaires were designed to discover essentially the same facts. They differ only because of the different age ranges at which they are aimed. The primary school questionnaire is of a form which is intended to keep young, easily distracted children interested. In the primary schools it was suggested that a lesson could easily be built around the questionnaires, so that the children get more out of it. Suggestions for a lesson were given to some of the schools. The secondary school questionnaire is designed to be more formal. This is intended to circumvent the problem of some children feeling that it is beneath them, an insult to their intelligence, or simply 'childish'.

When designing the primary school questionnaire, account was taken of a recent study on children's understanding of various words regularly used in road safety literature (Cattell and Lewis,1975). The questionnaire was built up so that traffic-related words which had been identified in this study as being poorly understood, or difficult for young children to read, were either omitted, changed to a word which was easier to understand or, where neither of these options were possible, included along with a pictorial representation of their meaning to improve understanding. Teachers were also present in the classrooms at the time of the completion of the questionnaires, and it was hoped that in this way any other problems could be overcome. In certain circumstances where questionnaires were sent home with children it was hoped that parents would be able to undertake a similar type of supervisory role.

There are some slight differences in the way the questionnaires were presented in each of the areas. These were largely due to the preferences of the Road Safety Officers and differences in the manner of presentation which, through local discussion, was thought best to interest the children in the area concerned, and to help encourage the headteachers to allow their children to take part. For instance in the Bristol area some of the questionnaires were sent out as part of a class project for children, containing the questionnaire, and several suggestions for activities related to this. It was suggested that completing the whole project, plus any other related activities would be worthwhile, but if this was not possible, due to time or other limitations, then the teachers were asked please to ensure at least the completion and return of the questionnaires.

5.4 Pilot Studies

Before the questionnaires were sent out, it was thought prudent to carry out at least one pilot study, to test firstly their comprehensibility, and secondly the ability of the children to complete the questions in an intelligible manner. In all, four pilot studies were eventually carried out.

5.4.1 The Sheffield pilot studies. Sheffield was chosen for the first studies because it had progressed furthest at the time in terms of negotiations with the Road Safety Officer. Two pilot studies were carried out in this city. The first of these was undertaken in 3 schools, using 4 classes of children: a second year infants school class; a fourth year junior school class; a second year secondary school class; and a third year secondary school class. All of these were in schools outside the study area, so that the possibility of children being asked to complete the questionnaire twice (once in the pilot and once in the main study) was prevented.

The returned questionnaires from these schools were mostly very encouraging. Preliminary analyses were carried out, largely to test the consistency of the replies. However, due to the small numbers of children involved, it is not thought worthwhile to discuss the results of these analyses here, apart from highlighting areas of concern with the technique which led to subsequent changes.

On the basis of these analyses, and from feedback from the teachers and road safety staff involved, one major change was made to both the questionnaires. This was to insert a question on the weather, so that allowance may be made for any effect that this might have upon children's journey characteristics when the data is analysed. Also it was decided to produce a set of notes for the teachers who would in future supervise the questionnaires. These notes are reproduced in Appendices B.4 and B.5. These were designed to help clear up small misunderstandings, for which it was not thought worthwhile to change the questionnaire directly. These notes would also help to improve the consistency of the answers. When the teacher was asked a question by a child, the notes would where necessary provide a means of identifying the intended manner of answering the question. It was stressed that the teacher should not answer all of the questionnaire for a child. Maps of the surrounding area were provided to each school where required.

The only major problem with these pilot studies arose when the results for the second year infants school class were considered. This class was unfortunately not able to answer the questions to the same standard as the other classes. Their teacher was of the opinion that the questionnaire was 'a little above their heads', and as such it was unpleasant for both her and the children to complete, for the latter because of the sense of failure they felt at the few questions they could answer, and for the former because of the problems of helping at the same time 20 out of 30 children who did not know what to do.

It was not known whether all classes containing younger children would react in the same way, as only one class was involved. However, it was decided that to be safe a solution to this problem should be found, without reducing the scope of the questionnaire. What was needed was some method of effectively increasing the availability of adult help, so that more individual help could be given to the children. This was done by sending the questionnaires home with the infants and first school children, along with an accompanying letter from the school asking parents if they could spare 20 minutes to help their child fill in the questionnaire. The form of this letter is given in Appendix B.6. It was stressed to the parents that they should help their child complete the questionnaire, rather than fill it in for them. Sending the questionnaires home meant that the response rate of the survey would probably not be as high (previously it was almost 100%), but this appeared to be the only practical solution to the problem. It was not possible to change the questionnaire more than had already been done, as a minimum amount of information was required to fulfil the aims of the project, and this could not be obtained without the questionnaire remaining in approximately its present form.

Using this method, a second pilot study was tried out in Sheffield in a second year infants school class, and in two first year junior school classes, to see roughly what proportion of the questionnaires were returned, and also that the questions were answered to a standard that would permit the required analysis. For all the three classes together, an average of 86% of the questionnaires were returned. From 90% of these, the results were of a usable standard. This represented a great improvement in the quality of results obtained from younger children over the first pilot study. It was thought that if this proportion of replies could be obtained in future, then any possible bias introduced by failure to return the questionnaires would be minimal.

Although the technique of sending the letter home with the younger children was used by some schools in the main Sheffield survey, other variations in the method were used elsewhere. In the Bristol main surveys, road safety staff went to the schools, and thus the teacher:pupil ratio was increased by a sufficient amount. In several of the schools in Bradford, Nelson and Reading the headteachers did not consider that their staff needed any help, though in some cases the questionnaires were sent home with a letter (see Appendix B.1 for details of which schools sent their questionnaires home).

5.4.2 The Nelson pilot studies. A third and fourth pilot study were carried out in Nelson. These were intended to help in devising a suitable method of analysis and to see if any other problems arose. They were also useful in helping to convince the Education Department in Nelson of the worth and feasibility of the studies.

Because the Nelson study area essentially consists of the whole of Nelson (and almost all of the schools), these pilot studies had to be carried out at schools within the study area, and which would be resurveyed during the main survey. Attempts were made to ensure that different classes would be involved in each of these surveys so that children did not have to respond twice. One of the main results to come out of these pilot studies was that children's memory of school journeys faded after a weekend, and that Monday was a less satisfactory day upon which to administer the questionnaire. For this reason the schools were asked not to complete the questionnaires on a Monday or the day after a holiday in the main survey. In general these two surveys showed that the method was sound, but that with younger children there was still a need to have as much supervision and help as possible.

5.5 The main exposure survey

The surveys in each of the areas were not completed at the same time of year. Nor were schools within an area surveyed at the same time. This would have been virtually impossible to arrange, and it was thought that a spread of journeys throughout the year would be more useful in some ways than having all the results relating to one short period of time, even though the ideal of spreading the survey systematically over the school year was also impracticable. The schools were asked to complete the questionnaires when they had spare moments in their timetables, and so it is likely that journeys on each of the weekdays will be represented. Unfortunately the request to omit Mondays as a survey day was not adhered to exactly. In some cases questionnaires that were taken home were filled in over a weekend and then returned the following week. It will be assumed that the journeys referred to in these were made on the Friday before the weekend.

5.6 Response rates

The schools which took part, and details of the numbers of questionnaires received from each are given in Appendix B.1. Table 5.1 shows the total response rates in each of the surveys in relation to the school populations of the areas, and the populations of school age children (the latter being obtained from the 1981 Census of Population).

This shows that in all of the areas there was a greater than 50% response rate. The major reasons for the response rate not approaching 100% were that within some schools in each of the study areas, various classes or parts of classes did not, for one reason or another, reply to the questionnaires. Also, some proportion of children in each class were no doubt absent at the time of the surveys. The response rate for the Nelson area was particularly low, compared to the others, because of a misunderstanding which meant that very few replies were received from 2nd and 3rd year classes in junior schools.

Table 5.1: Response rates from the questionnaire surveys.

Area	Date of Survey	No. of forms returned	No. of forms given out	Response Rate	Number of usable forms	Population of schools	Resident population (4-15 years)	Proportion of school population surveyed
Sheffield	12.7.83-24.7.83	1657	2513	65.0%	1634	10597	8137	15.4%
Bristol	26.4.83-7.7.83	1996	2713	72.0%	1954	7163	5498	27.3%
Nelson	10.10.83-25.11.83	1024	1997	50.1%	1001	4880	5101	20.5%
Bradford	7.9.83-30.9.83	1547	2141	70.1%	1501	5931	5997	25.3%
Reading	9.5.84-12.10.84	2035	2987	66.4%	1982	7699	6914	25.7%

5.7 Coding

The task of coding the questionnaires has proved to be extensive. Every response to each questionnaire has had to be checked, coded and added to the data sets stored on the computer. Appendix B.7 gives details of all the variables coded, and the categories being used in the analysis.

5.7.1 Explanation of the variables in the data set.

The meaning and derivation of most of the variables is obvious. However, one set of variables in particular require a little explanation. These are the 50 entitled 'RIOne' to 'RITFive' (Road In One to Road In Twenty-Five) and 'ROOne' to 'ROTFive' (Road Out One to Road Out Twenty-Five). These were set up so that the exact route taken by each child on the way to school, and on the way home could be defined on the computer. The location of each road crossing by a child was given a number. These numbers are stored on large scale maps of the areas for future reference. Thus variable RIOne contains the location code of the first road crossed on the way to school, RITwo the second, RIThree the third, and so on. Similarly on the way home ROOne contains the code for the first road crossed, ROTwo the second, and so on. Twenty five road crossings could be accommodated on each journey, and this figure was never exceeded. If a child only crossed 3 roads on the way to school, for instance, then RIOne might be coded as '323', RITwo as '317', and RIThree as '004'. Variables RIFour to RITFive would all be coded as '000', which means 'no road crossed'. If a road crossing location was unknown, then '999' would be entered (three digits were always used for these codes, to allow for up to 998 road crossing locations within each area).

The road crossing locations (hereafter referred to as 'links') are defined as being the stretch of road between two junctions, which can be on either side of the road. Thus, by definition, all road 'links' will be of different lengths, some being only a few feet long and others, depending on the nature of the areas, much longer. Children were not asked to record where on the 'link' that they crossed the road. It was thought that traffic flow along any one 'link' would be reasonably consistent from end to end, and so this information would not really be necessary in order to assess the flow of traffic crossed.

Figure 5.1 shows the route of a typical journey to a primary school in the Sheffield study area. This route ties in with the data recorded on the example of a primary school questionnaire given in Appendix B.2. The 'link' coding for this route would be as follows: RIOne='611', RITwo='612', RIThree='613', RIFour='610', RIFive='599' and RISix to RITFive='000' (because only five roads were crossed). On the way home the 'link' codings would be: ROOne='599', ROTwo='611', and ROThree to ROTFive='000'.

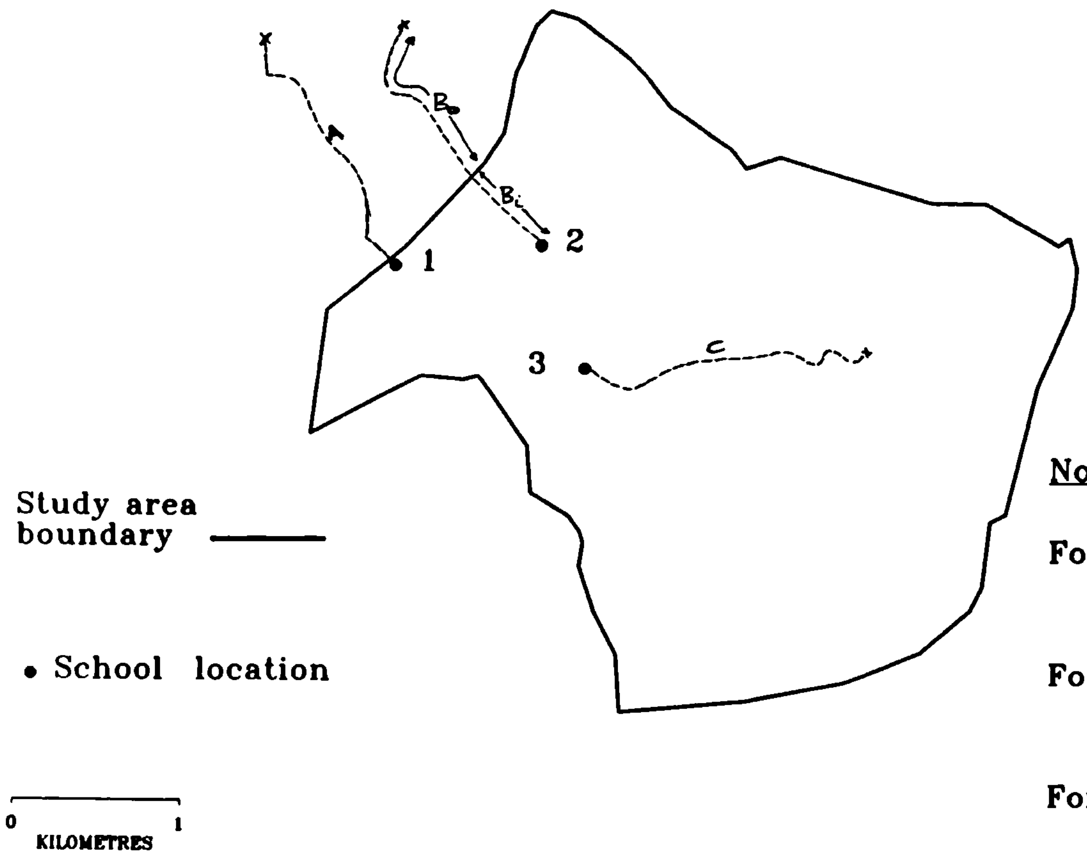
Distance travelled to and from school was measured for each child using their stated route, and measuring this on large scale maps. The distance measured was the total distance walked on a journey. Thus sections of a journey that were travelled by car, bus or bicycle were not included in this measure. Distance travelled outside the study area was included. This measure was incorporated into the data sets as variables called 'Distin' and 'Distout' (see Appendix B.7). The way in which distances travelled within and outside the area were distinguished in the data is described in Section 5.1.2.

Although the exact address of each child was not asked for on the questionnaires (only the road name was required), this information, in combination with the name of the first road crossed on the way to school, was sufficient to determine the 'block' on which he/she lived. In no case in the study areas did an Enumeration District (E.D.) boundary cut through a 'block'. Thus, it was possible to work out for each child, from the information given on the questionnaire, the E.D. in which they lived. This information is useful in two ways. Each E.D used in the 1981 census has a six figure grid reference denoting the position of its 'centroid'. Thus, an independent straight line measure of the distance travelled on a journey, from the grid reference of this centroid to the grid reference of the school, could be calculated. If this was found to be a suitable approximation of the actual distance as measured above, then the long process of measuring each distance could be avoided in future studies. It should be noted that this measure would not take account of any deviations from a straight path taken by children, or differences between the lengths of journeys to and from school. The variable 'ED' also means that variables from the 1981 census can be tied in with the exposure study. For instance journey length, or mode of travel could be related to variables such as socio-economic status of neighbourhood of residence.

Each questionnaire was allocated a quality code as the final variable, which identified how well it was completed, or the degree to which the results were thought to be possibly spurious. These ranged from excellent, where everything was seemingly correct, through good, and workable, where more and more information had to be extrapolated, to poor where virtually nothing about the roads crossed was known except the origin and destination of the journey. Questionnaires where the origin of the journey could not be ascertained were left out of the analyses (see Table 5.1 for proportions).

5.7.2 Extra variables subsequently added to the data sets. As well as the more obvious variables to be coded from the questionnaires, several others have subsequently been derived and added to the data sets. The variables 'Distin', 'Numin', 'Timein', 'Distout', 'Numout', and 'Timeout' relate to the total distance travelled, the total number of roads crossed, and the total time taken on the journey to school, and the journey home. However, the accident data relate only to accidents which happened in the study areas. Thus, so that the data sets could be compared, new variables had to be created containing information on the distance travelled in the study area, the number of roads crossed in the study area, and the time taken in the study area. Where a journey was completely carried out in the study area no change had to be made. New variables called 'Idist', 'Itime', and 'Inum' for the journey to school, and 'Odist', 'Otime', and 'Onum' for the journey home were created. The variables 'Itime' and 'Otime' were in fact estimated using the distance variables, as it was not actually known how much time was spent walking in the study areas. Thus these are not independent of distance. Figure 5.2 helps to explain the changes that were made to the variables 'Distin' and 'Distout' to create the new variables 'Idist' and 'Odist'.

Figure 5.2: Explanation of the differences between the variables Distin and Idist for a set of routes to schools in the Reading Study Area



Notes

For Route 1: Distin=A (km)
Idist=0km

For Route 2: Distin=Bo + Bi (km)
Idist=Bi (km)

For Route 3: Distin=C (km)
Idist=C (km)

5.8 Storage of the data sets

Initially the data was transferred from coding forms to punched cards so that it could be entered onto disc. At this stage, the data did not contain the many zero entries for variables 'RIOne' to 'RITFive, and 'ROOne' to ROTFive' described in Section 5.7.1. This meant that the number of cards, and the time spent punching them were reduced. Once these data were entered onto disc, a computer program was used to replace the missing zeros. These extended data files were subsequently stored at the University of London Computer Centre (ULCC) using a computer package called Statistical Analysis System (SAS), (SAS,1982). For further information about this computer package it is recommended that reference be made to the SAS User's Guide: Basics (SAS,1982), and to the ULCC documentation manuals, particularly those referring to Job Control Language (JCL). Retrieval of data, and a large range of other statistical manipulations are possible using the package. These range from simple tabulations, to complex linear modelling. The data are stored on 5 separate data sets, one for each study area. These are called .Braddist, .Brisdist, .Nelsdist, .Readdist, and .Shefdist.

5.9 The quality of the responses

Table 5.2 shows the recorded 'Quality' of the returned questionnaires for each of the study areas.

Table 5.2: Standard of coded questionnaires.

		Excellent	Good	Workable	Poor	Total
Bradford	Number	954	401	94	52	1501
	Percent	63.5	26.7	6.3	3.5	100.0
Bristol	Number	1220	467	184	83	1954
	Percent	62.5	23.9	9.4	4.2	100.0
Nelson	Number	658	246	68	29	1001
	Percent	65.7	24.6	6.8	2.9	100.0
Reading	Number	1558	320	62	42	1982
	Percent	78.6	16.1	3.1	2.1	100.0
Sheffield	Number	986	381	203	64	1634
	Percent	60.4	23.3	12.4	3.9	100.0
Total number		5376	1815	611	270	8072

As can be seen, a large number of the questionnaires were completed to a very high standard, and in roughly the same proportions for each area. Other studies have shown, that when asked to describe their journeys to and from school, children tend to underestimate the numbers of roads they crossed (Routledge et al,1974b). This is confirmed in this study, as all those children who did not score 'excellent', underestimated to some extent the number of roads they crossed. However, it was found that in most of these cases, as some of the roads crossed were recorded, it was possible to work out the remainder of the roads that must have been crossed, from these. It is this estimated figure which has been inserted in the data sets as the variables 'Numin' (the number of roads crossed on the way to school), and 'Numout' (the number of roads crossed on the way home).

CHAPTER 6

RESULTS FROM THE QUESTIONNAIRE SURVEYS OF CHILDREN'S JOURNEYS TO AND FROM SCHOOL

This chapter is set out in three parts. The first of these examines how representative the information collected from the sampled populations in each of the study areas was of the characteristics of the total school populations in those areas, and how this was assessed. This section also considers some of the limitations of the sample data sets.

The second part of this chapter examines some of the information collected by the questionnaire surveys for each area about children's exposure to risk. In particular this section examines the mode of travel, accompaniment, the number of roads crossed, the distance walked (actual road distance), and the time taken, on the journeys to and from school by the children in the samples. In these analyses the total number of roads crossed, the total distance walked, and the total time taken by each child are considered, regardless of whether or not the child's journey took them outside the boundaries of the study area. The results of each of the 5 surveys are, where possible, considered together and relevant comparisons between the different study areas are made. Finally this section also briefly considers exposure to risk at lunchtimes, though due to a lack of information this is not covered in as great detail as the journeys to and from school.

The final part of the chapter concerns the construction of measures of accident risk for the population of children in each of the study areas, and for subsets of these populations, by the combination of the measures of exposure to risk described above, and some of the accident statistics relating to the journeys to and from school, which were analysed in Chapter 3. The measures of exposure to risk used in these analyses relate to the study areas only, so that the results are directly comparable to the accident statistics. No measures of accident risk were derived for lunchtime journeys. This was because of the limited amount of information available on exposure to risk at this time, and also because of the very small numbers of accidents occurring at lunchtimes.

6.1 Limitations and weighting of the sample

The aim of the surveys described in Chapter 5 was to obtain information from a sample of children from each of the study areas about their exposure to risk of a road accident while on a journey to or from school. The structure of these samples was designed so that the information collected from each school would be representative of the whole population of that school (i.e. the aim was to collect information from one class in each year group within each school on the assumption that each class would be representative of its year as a whole and that the whole sample would thus be representative of the school population). The sample data collected in this manner could then be weighted to the level of the school populations and combined with the accident statistics for the study areas to produce measures of accident risk, both for the school populations of the 5 study areas, and for subsets of these populations. However, for various reasons the data collection did not go entirely to plan, and it became necessary to assess how representative the information obtained from the sample in each school was of the population of that school as a whole.

Questionnaire responses from all of the schools were only collected in the Bradford, Bristol, and Reading study areas. In the other two areas a few schools failed to reply. Also in some of the schools in each of the areas, one or more of the year groups were missed out, or less than a full class replied. In those cases where a whole school failed to take part in the survey, they have had to be omitted from the analyses, along with any accidents which occurred to children going to or from that school. However, in those cases where year groups within a school were not sampled, or less than a full class from a year group replied to the questionnaire survey, it was still possible to make some estimate of the journey characteristics of the missing children. This was done by modelling the data using a computer package called GLIM (Baker and Nelder,1978). Essentially this type of modelling uses the sample data that has been collected, and by an assessment of the patterns within that data, makes an estimate of the likely patterns which would have existed in the sample had it been complete. Obviously this can only be done for those schools which supplied some responses to the questionnaires. Use of this method means that patterns of variation between years within particular school types, or between schools of the same type can be identified, not just for schools which supplied the correct sample data, but also for those where some of the data was missing.

Models of this type were used to test whether there was any variation in the patterns of exposure to risk (using each of the exposure to risk measures in turn) between years within schools of the same type (i.e. first, infants, middle, juniors, and secondary). If it was shown that there was a reasonable statistical likelihood (the 0.05 level of confidence was used) that any variation in the measures of exposure to risk between years within schools of the same type was due to chance, then it could be considered that in terms of those measures, the sample was representative of the complete school population, and that it would be reasonable to weight the sample data retrieved from each school up to the level of the school population regardless of the number of responses received from different year groups and without fear of bias. Alternatively, if it was shown that a statistically significant variation existed in the exposure to risk measures between years within schools of the same type, then it would not be appropriate to weight the data directly to the level of the school populations, as due to the limitations of the sample, bias would thus occur (i.e there may have been disproportionate numbers of 1st and 4th years within the sample). In these circumstances account would have to be taken of the proportions of the sample which were obtained for each of the year groups, when weighting the data.

Such analyses were carried out for each of the school types, in each of the study areas, for both the journey to school in the morning and the journey home in the afternoon. They were carried out both for the total number of roads crossed, the total distance walked, and the total time taken on journeys to and from school, and for the number of roads crossed, distance walked, and time taken within the study areas.

Details of the models used for each of the measures of exposure to risk are given in the next section.

Other possible limitations of the data exist. As shown in Table 5.1 the surveys in each of the study areas were carried out at different times of the year, and so when comparisons between them are made, the possible effects of seasonality should be borne in mind. No objective allowance can be made for this difference at this point, because the individual surveys did not cover a wide enough range of dates to indicate reliably whether any such seasonal variations in say the mode of travel or accompaniment existed, let alone to quantify them.

Finally, weather conditions, in particular whether it was raining or not, may have had an effect upon the travel characteristics of the children. It was thought that the most likely variable which would show up this effect was the mode of travel. Chi-square tests were carried out for both of the journeys in each of the study areas, to show if there was any statistically significant difference (at the 0.05 level of confidence) between modal choice on journeys when it was not raining, and on journeys when it was raining. Table 6.1 shows the proportions of reported journeys made when it was raining in each of the study areas.

Table 6.1: Percentage of reported journeys in each of the study areas made when it was raining.

Area	To school	From school	Base
Bradford	2.1%	13.5%	3662
Bristol	9.8%	6.8%	5352
Nelson	0.9%	0.5%	2169
Reading	4.8%	10.8%	7027
Sheffield	15.7%	0.5%	7177

It can be seen that in some of the areas, there were too few journeys made in the rain for such analyses to be worthwhile. However, it was shown in all cases where there was a large enough proportion of journeys made in the rain, that a statistically significant relationship existed between wet and dry conditions and mode of travel. However, the nature of this relationship varied between the areas and journeys. For Bradford it was found that more children went home by car when it was raining, and fewer walked, than when it was not raining. The same was also true in the Bristol area on the way home, but on the way to school in this area fewer children went by car when it was raining, and more walked, than when it was not raining. In the Reading area on the way home, slightly more children travelled by car and walked and many fewer children travelled by bus, when it was raining than when it was not. Finally in the Sheffield area on the way to school, more children travelled by bus and fewer on foot and by car when it was raining than when it was not. In general these analyses showed that a relationship did exist between wet weather and mode of travel by children on journeys to and from school, for all those cases where it was possible to test such a relationship, but that it was by no means consistent.

6.2 Exposure to risk

This section examines the variables most relevant to exposure to risk (mode of travel, accompaniment, number of roads crossed, distance walked, and the time spent in the road environment) in turn, and the variation in these between the 5 study areas, between different school types within the study areas, between schools of the same type, between year groups within those schools, and between sexes of child. Patterns of exposure to risk for lunchtime journeys are also briefly discussed.

6.2.1 Mode of travel.

Six modes of travel were recorded in the questionnaire surveys. These were:-

a. Walking the whole journey
b. Travelling some or all of the journey by public bus
c. Travelling some or all of the journey by school bus (these are buses that are run by the school or the Local Education Authority specifically for the use of their children)
d. Travelling some or all of the journey by private car
e. Travelling some or all of the journey by bicycle
f. Travelling by some other mode

Modes (b) to (f) can all involve some walking, and account will be taken of this in some of the measures of exposure to risk. For the purposes of these analyses, options (b) and (c) have been grouped together due to their similarity, because of the small numbers of children using option (c) in all but the Sheffield study area, and because in some of the areas, the primary school questionnaire did not contain category (c).

It is intended in this section to discuss some of the variations in the modal split between the study areas, between school types within these areas, between the two sexes, between individual schools, and between year groups within schools, both for the journey to school and the journey home. The assessment of the variation in modal split in each case was carried out using GLIM. A log linear model with a Poisson error structure was fitted to data for each school type (first, infants, middle, junior, and secondary), each study area, and each journey separately. The models fitted were of the form:

$$n_{ijkl} = \exp\{a + b_i + c_j + d_k + e_l + f_{ik} + g_{jk} \ldots\}$$

where i = name of the school (1=<i=<the number of schools of a particular type in an area).

j = year in school (1=<j=<the number of years within each of the school types).

k = mode of travel (1=<k=<5).

l = sex of child (1=<l=<2).

and n_{ijkl} is the corresponding number of respondents in the survey.

The statistical significance of the reduction in deviance brought about by fitting the 2 way interaction terms 'schoolname.mode', 'year.mode', and 'sex.mode', and the three way interaction 'sex.year.mode' to the model, was ascertained for each of the school types in each study area, and for each of the two journeys. This was done by comparing the reduction in deviance and in the degrees of freedom, brought about by fitting each of the various terms to the model, with a Chi-square distribution. The 0.05 level of confidence was selected as being the level at which the null hypothesis (i.e. that no relationship exists between the factors in each of the interactions) was rejected. Table 6.2 shows these results.

It can be seen that in most cases the modal split varied significantly between schools of the same type in an area (e.g. first schools in Sheffield had a statistically significant difference in their modal splits). This was to be expected, because the location of each school, with respect to the location of its pupils, would be different, as would the relative affluence of the pupils, and thus the availability of particular modes of transport.

It can also be seen that in only a few cases did the mode of travel vary significantly within a type of school between children in different years, between children of different sexes, or between children of different sexes within a given year. In terms of variation between years within schools, of the few instances where this was shown to be statistically significant, most were in secondary schools. This was to be expected to some extent because of the generally greater choice (and freedom of choice) that these children have over their mode of travel, compared to younger children.

Table 6.2: Results of GLIM runs looking at variations in modal split.

Data sets for each study area and school type	Fitted interaction terms							
	Schname.mode		Year.mode		Sex.mode		Sex.year.mode	
	to*	from*	to	from	to	from	to	from
Bradford:								
First	Y	Y	-	-	-	-	-	-
Middle	Y	Y	-	-	Y	Y	-	-
Secondary	-	-	-	-	-	-	-	-
Bristol:								
Infants	Y	Y	-	-	-	-	-	-
Juniors	-	-	-	-	Y	Y	-	-
Secondary	Y	Y	-	-	Y	Y	-	-
Nelson:								
Infants	Y	Y	-	-	-	-	-	-
Juniors	Y	Y	-	-	-	-	-	-
Secondary	Y	-	-	-	Y	-	-	-
Reading:								
Infants	Y	Y	-	-	-	-	-	-
Juniors	Y	Y	Y	Y	Y	Y	-	-
Secondary	Y	Y	Y	Y	-	-	-	-
Sheffield:								
First	Y	Y	-	-	-	-	-	Y
Middle	Y	-	-	Y	-	-	-	Y
Secondary	-	-	Y	Y	-	-	-	-

Y = Reduction in deviance as a result of fitting this factor was significant at the 0.05 level of confidence (i.e. the null hypothesis was rejected).

- = Reduction in deviance as a result of fitting this factor was not significant at the 0.05 level of confidence (i.e. the null hypothesis was accepted).

* - 'to' means on the journey to school, and 'from' means on the journey home.

Table 6.3 shows the variations in modal split between the different school types, for both the journeys to and from school, in each of the study areas. The figures in this table have been weighted to the level of the individual school populations, and then summed for each of the types of school and for each of the study areas as a whole. Because of the lack of variation in modal choice within individual schools, which for most of the types of schools in the study areas was shown to be so in Table 6.2, it was not considered necessary to weight by school year or sex. The figures in this table can be taken to represent the modal split of children in each area travelling to and from schools of the relevant type from which sample data was obtained taken together. Because there was statistically significant variation in modal split between schools of most types in most areas, the percentages in Table 6.3 should not be taken to apply to any individual school.

Table 6.3: Percentages of children travelling to and from surveyed schools by mode of travel.

Study area and school type	Mode of travel					Base
	Walk	Bus	Car	Bicycle	Other	
Bradford:						
First	76.9 (+3.3)	4.5 (-0.1)	18.1 (-3.3)	- (-)	0.4 (+0.5)	2298
Middle	73.8 (+3.2)	11.0 (+0.8)	13.8 (-3.8)	0.4 (-)	0.8 (-0.2)	2045
Secondary	84.9 (+0.8)	10.9 (-0.8)	4.2 (-0.8)	- (+0.8)	- (-)	1190
Total	77.5 (+2.6)	8.3 (-)	13.5 (-2.9)	0.1 (+0.2)	0.5 (+0.2)	5533
Bristol:						
Infants	70.3 (+2.9)	5.8 (+0.1)	23.9 (-4.3)	- (+1.3)	- (-)	876
Juniors	78.7 (+1.9)	3.5 (+0.7)	17.2 (-3.3)	0.6 (+0.8)	- (-)	1729
Secondary	68.1 (+5.4)	11.9 (+2.1)	13.2 (-8.2)	12.8 (+0.4)	0.9 (+0.3)	3435
Total	67.4 (+4.1)	8.6 (+1.4)	15.9 (-6.2)	7.5 (+0.6)	0.5 (+0.2)	6040
Nelson:						
Infants	80.2 (-0.6)	3.9 (+1.9)	15.8 (-1.3)	- (-)	- (-)	722
Juniors	84.6 (+1.4)	3.8 (-0.3)	11.5 (-1.6)	- (+0.8)	- (-)	1600
Secondary	62.8 (+5.1)	21.4 (+2.7)	13.0 (-7.6)	1.1 (-)	1.4 (+0.1)	1620
Total	74.8 (+2.6)	7.6 (+1.6)	12.9 (-4.0)	0.4 (+0.3)	0.6 (-)	3942
Reading:						
Infants	73.8 (-0.2)	2.7 (-0.6)	23.4 (+0.7)	0.1 (-)	- (-)	1399
Juniors	69.8 (+5.4)	4.7 (-)	22.8 (-3.5)	2.7 (-0.9)	- (-)	2301
Secondary	46.8 (+2.4)	32.3 (+0.1)	12.4 (-2.4)	7.3 (+0.2)	1.1 (-0.2)	3326
Total	59.7 (+2.9)	17.4 (-0.1)	18.0 (-2.1)	4.4 (-0.5)	0.5 (-0.1)	7026
Sheffield:						
First	86.7 (+3.6)	5.9 (-2.8)	7.3 (-0.8)	- (-)	- (-)	1470
Middle	84.7 (+4.6)	10.1 (-2.5)	5.0 (-2.5)	0.1 (+0.4)	- (-)	2190
Secondary	56.1 (+2.0)	40.2 (-0.4)	2.8 (-1.9)	0.6 (-0.2)	0.2 (+0.5)	4404
Total	69.5 (+3.0)	25.8 (-1.4)	4.3 (-1.9)	0.4 (-)	0.1 (+0.3)	8064

The figures show the proportion of pupils using a particular mode of travel on the journey to school, and in brackets, the difference between this and the journey home. A positive figure means that a larger proportion of children used that mode on the journey home than on the journey to school, while a negative figure means the opposite.

The base of this table refers to the total population of surveyed schools from which a sufficiently large sample of questionnaire responses were obtained.

Figures for secondary schools are for the first 5 years of those schools only.

The table shows that there were some differences between the modal split on the journey to school and on the journey home. In each of the study areas a larger proportion of children walked all the way home from school in the afternoon than walked to school in the morning. This difference would seem to be largely accounted for by a decrease in the proportions of children who were taken by car on the way home. The major reason for this is possibly that less parents were available in the afternoon to drive their children home, due to work commitments, while in the morning it is often possible to drop children off at school on the way to work. In some of the areas there was an increase in bus use in the afternoon, perhaps also a result of the above effect. The drop in the numbers of children travelling by car in the afternoon and the rise in the number of children walking was true for each of the areas in total, although a slight increase in car usage in the afternoon was noted in Reading infant schools, and a drop in walking in the afternoon in Reading and Nelson infant schools. The drop in car usage between the morning and afternoon journeys ranges from 1.9% in the Sheffield area, to 6.2% in the Bristol area, and the increase in walking from 2.6% in the Bradford and Nelson areas, to 4.1% in the Bristol area. The drop in car usage between the morning and afternoon journeys appeared to be larger overall in secondary schools, than in primary schools. Possibly this was because a greater effort was made by parents to bring primary school children home by car compared to secondary school children.

In all the study areas, except perhaps Nelson, larger proportions of primary school than secondary school children travelled to and from school by car, possibly because parents of such young children were more worried about them both in terms of general safety and road safety, than they were about older children. In all the areas apart from Bradford, a substantially smaller proportion of secondary school children walked to and from school than primary school children. The Bradford figure may possibly be misleading as only one secondary school exists in the area, and from this only 3rd year children were included in the sample.

Modal split varied appreciably between the study areas. The Reading area contained the lowest proportion of children who walked on both journeys. The Reading and Bristol areas had the highest proportions of children who were taken to and from school in a car. Tables 3.1 to 3.3 have shown that these areas had the highest car ownership levels and were, using a variety of measures, the most affluent areas. The Sheffield area had the lowest proportions of children using a car on the journeys to and from school, and also the lowest levels of car ownership. However, a larger proportion of children in the Sheffield area travelled to and from school by bus, compared to the other areas. This is probably partly a response to the low car ownership levels, but also no doubt because of the high standard of the bus service in this area and its low fares compared to the other areas. Bicycle use also varied considerably, with the two southern towns, Bristol and Reading, having the only appreciable amounts of bicycle use of the 5 areas. This could possibly be due to school policies, the relative affluence of the two southern areas, or the hillier nature of the three northern areas. Bicycle use was largely restricted to secondary school children.

6.2.2 Accompaniment. The various types of accompaniment which were listed on the two questionnaires (see Appendices B.2 and B.3) were split into 5 groups. In this way the results from the secondary school questionnaire could easily be compared with those from the primary school questionnaire. These five groups were:

a. Alone
b. With older people including older brothers and sisters, adults and neighbours
c. With friends or contemporaries
d. With younger children
e. With other people recorded on the questionnaire (this group seems to consist of aunts, uncles and cousins, though it is not known if these people are older, younger, or contemporaries)

It is intended in this section to discuss some of the variations in the levels and types of accompaniment in each of the study areas, between types of school within the areas, between individual schools of the same type within an area, between years within schools of the same type, and between boys and girls for both the journeys to school in the morning and home in the afternoon. The assessment of the variation in accompaniment in each case was carried out using GLIM. A log linear model with a Poisson error structure was fitted to the data for each school type, and each journey in each study area separately. The models fitted were of the same form as those in the previous section. That is:

$$n_{ijkl} = \exp\{a + b_i + c_j + d_k + e_l + f_{ik} + g_{jk} \ldots\}$$

where i = name of school (1=<i=<the number of schools of a particular type within an area).

j = year in school (1=<j=<the number of years within each school type).

k = accompaniment (1=<k=<5).

l = sex of child (1=<l=<2).

and n_{ijkl} is the corresponding number of respondents in the survey.

The statistical significance of the reduction in deviance brought about by fitting the two way interaction terms 'school name.accompaniment', 'year.accompaniment', and 'sex.accompaniment', and the three way interaction term 'sex.year.accompaniment' to the model, was ascertained for each of the school types in each study area, and for both of the two journeys. This was done in the same manner as for the mode of travel described in the previous section. It was shown that in almost all cases fitting the interaction term 'school name.accompaniment' resulted in a significant reduction in deviance. This is probably because the individual circumstances of each school (such as the nearness to main roads) had a large effect upon whether or not parents or other adults felt they needed to accompany their children, or whether the child was allowed to travel alone or with friends.

In a few cases it was shown that fitting the interaction term 'sex.accompaniment' resulted in a significant reduction in deviance.

In these cases it was always shown that girls were accompanied by adults more than boys, and travelled alone and with friends less. In no circumstances was it found that fitting the three way interaction term 'sex.year.accompaniment', resulted in a significant reduction in deviance.

Finally it was shown that in virtually all cases, fitting the two way interaction term 'year.accompaniment', resulted in a significant reduction in deviance. These variations will now be considered in more detail (where they have been shown to be statistically significant), as well as other variations between types of school, between the study areas, and between the journeys to and from school, in Tables 6.4 to 6.8.

It can be seen from these tables that the proportion of children accompanied by friends on both the journeys to and from school, was greater in junior and middle schools, than in infants or first schools, and greater still in secondary schools. Within particular types of schools there was also a tendency for the youngest age groups of children to be accompanied by friends the least, and the oldest age groups to be accompanied by friends the most. For most school types as a whole, and for years within them, the proportion of children accompanied by friends in the afternoon was greater than that in the morning. This was particularly the case in secondary schools. In all the areas except Nelson, more than half of the secondary school children were accompanied by friends both on the way to and from school.

Table 6.4: Proportions of children attending different types of school who were accompanied by various types of people while travelling to and from surveyed schools in the Bradford study area.

School type and year	Accompaniment					Base
	Alone	Friends	Younger children	Older People	Other/ Unknown	
First*:						
3rd year	14.4 (+2.9)	5.8 (+1.8)	1.9 (-0.5)	72.2 (-10.6)	5.8 (+6.3)	460
4th year	18.3 (+1.9)	12.1 (+5.4)	2.7 (+0.4)	61.9 (-8.5)	5.0 (+0.8)	460
5th year	23.1 (-3.4)	14.8 (+8.6)	6.8 (-0.7)	51.9 (-7.6)	3.4 (+3.1)	460
Total	18.6 (+0.5)	10.9 (+5.3)	3.8 (-0.3)	62.0 (-8.9)	4.7 (+3.4)	1380
Middle**:						
1st year	18.0	42.7	0.9	35.0	3.4	511
2nd year	27.0	45.1	2.4	24.6	0.9	511
3rd year	24.9	62.2	6.6	4.2	2.0	511
4th year	19.3	54.8	8.1	15.6	2.2	511
Total	22.3 (-1.4)	51.2 (+4.9)	4.5 (-1.5)	19.9 (-2.0)	2.1 (-)	2045
Secondary:						
3rd year	20.2 (-6.8)	66.4 (+8.4)	0.8 (-)	10.9 (-)	1.7 (-1.7)	238

The figures show the proportions of pupils accompanied by different people on the journey to school, and in brackets, the difference between this and the journey home. If the figure is positive then a larger proportion of children were accompanied on the journey home than on the way to school, while if it is negative the opposite is the case.

* As shown in Chapter 5, insufficient questionnaires were returned from the 1st and 2nd years to include them in these analyses. Only results from 3rd years were available from secondary schools.

** No significant difference in accompaniment was found between children in each year group in middle schools on the way home, and so only the total figures are given for this group.

Table 6.5: Proportions of children attending different types of school who were accompanied by various types of people while travelling to and from surveyed schools in the Bristol study area.

School type	Accompaniment					Base
	Alone	Friends	Younger children	Older People	Other/ Unknown	
Infants:						
1st year	3.0 (-0.7)	5.3 (+1.5)	- (-)	91.7 (-0.7)	- (-)	292
2nd year	9.0 (+3.6)	16.2 (+4.8)	- (-)	74.9 (+1.2)	- (-)	292
3rd year	11.3 (+8.7)	12.0 (-2.7)	- (-)	76.7 (-6.0)	- (-)	292
Total	7.8 (+3.8)	11.2 (-2.0)	- (-)	81.1 (-1.8)	- (-)	876
Juniors:						
1st year	22.6 (+4.8)	22.1 (+1.8)	- (-)	55.3 (-6.8)	- (-)	432
2nd year	29.4 (-0.7)	31.5 (-2.1)	- (-)	39.1 (+2.8)	- (-)	432
3rd year	23.3 (+4.5)	44.4 (+0.1)	- (-)	32.4 (-4.6)	- (-)	432
4th year	37.5 (-7.5)	43.4 (+8.5)	- (+0.4)	19.1 (-1.4)	- (-)	432
Total	28.2 (+0.3)	35.4 (+2.0)	- (+0.1)	36.5 (-2.5)	- (-)	1728
Secondary*						
1st year	21.2 (+5.0)	49.2 (+7.5)	1.7 (-1.7)	22.9 (-9.3)	5.1 (-1.7)	687
2nd year	25.7 (+0.9)	56.6 (+8.9)	- (-)	15.9 (-8.1)	1.8 (-1.8)	687
3rd year	24.8 (-7.4)	46.8(+23.0)	5.5 (-2.7)	22.0(-12.9)	0.9 (-)	687
4th year	36.7(-12.3)	50.0(+18.4)	2.0 (-1.1)	9.2 (-6.0)	2.0 (+1.2)	687
Total	27.1 (-3.4)	50.7(+14.4)	2.3 (-1.4)	17.5 (-9.0)	2.5 (-0.6)	2748

The figures show the proportions of pupils accompanied by different people on the journey to school, and in brackets, the difference between this and on the journey home.

* - No replies were received from children in the 5th year of secondary schools

Table 6.6: Proportions of children attending different types of school who were accompanied by various types of people while travelling to and from surveyed schools in the Nelson study area.

School type	Accompaniment					Base
	Alone	Friends	Younger children	Older People	Other/ Unknown	
Infants*:						
Total	10.0 (+0.9)	32.7 (+1.5)	1.4 (-0.7)	56.0 (-1.7)	- (-)	722
Juniors**:						
1st year	31.4 (-2.2)	23.6 (+5.6)	- (-)	45.0 (-3.5)	- (-)	400
4th year	38.3(-10.0)	41.1(+11.8)	- (-)	20.6 (-1.8)	- (-)	400
Total	34.9 (-6.1)	32.4 (+8.7)	- (-)	32.8 (-2.6)	- (-)	800
Secondary:						
2nd year	14.5 (-)	46.4(+14.7)	2.9 (-2.9)	33.3 (-9.4)	2.9 (-1.5)	324
4th year	29.7 (-4.3)	42.0(+14.5)	4.3 (+0.8)	20.3 (-9.4)	3.6 (-1.4)	324
Total	22.1 (-2.1)	44.2(+14.1)	3.6 (-1.0)	26.8 (-9.4)	3.3 (-1.5)	648

The figures show the proportions of pupils accompanied by different people on the journey to school, and in brackets, the difference between this and the journey home.

* No significant differences in accompaniment were found between years within infants schools, and so only the total figures are presented here.

** No results are available from 2nd and 3rd years in junior schools, or from 1st, 3rd, and 5th years in secondary schools.

Table 6.7: Proportions of children attending different types of school who were accompanied by various types of people while travelling to and from surveyed schools in the Reading study area.

School type	Accompaniment					Base
	Alone	Friends	Younger children	Older People	Other/ Unknown	
Infants:						
1st year	2.8 (-0.5)	3.4 (+0.6)	1.1 (-)	92.7 (-)	- (-)	466
2nd year	7.8 (+2.3)	7.0 (+0.8)	0.4 (+0.1)	84.8 (-3.1)	- (-)	466
3rd year	9.3 (-0.7)	12.6 (+0.6)	0.7 (-)	77.5 (-)	- (-)	466
Total	6.6 (+0.4)	7.7 (+0.6)	0.7 (+0.1)	85.0 (-1.0)	- (-)	1399
Juniors:						
1st year	16.4 (+6.5)	25.2 (+1.7)	- (-)	58.4 (-7.5)	- (-)	575
2nd year	16.3 (+3.0)	34.6 (-1.8)	- (+0.4)	49.1 (-1.6)	- (-)	575
3rd year	26.7 (+5.6)	30.6 (+4.1)	1.3 (+0.6)	41.4(-10.3)	- (-)	575
4th year	32.6 (-1.1)	38.9 (+8.2)	0.8 (-0.8)	27.7 (-6.4)	- (-)	575
Total	23.0 (+3.5)	32.3 (+3.1)	0.5 (+0.1)	44.2 (-6.5)	- (-)	2301
Secondary:						
1st year	19.2 (+5.9)	50.0 (-4.1)	1.7 (-0.9)	28.4 (-2.8)	0.8 (-)	665
2nd year	15.9 (+2.3)	57.6 (+3.1)	- (+0.7)	26.6 (-6.9)	- (+0.7)	665
3rd year	27.9 (-3.7)	49.2 (+8.3)	3.9 (-)	19.0 (-7.6)	- (+3.1)	665
4th year	26.2 (-5.8)	49.6 (+8.6)	8.7 (-1.1)	13.6 (-2.0)	1.8 (+0.2)	665
5th year	34.5 (-7.6)	44.1(+19.3)	2.1 (-2.1)	17.2 (-9.4)	2.1 (-0.2)	665
Total	24.7 (-1.7)	50.1 (+7.0)	3.3 (-0.7)	21.0 (-5.8)	0.9 (+0.8)	3326

The figures show the proportions of pupils accompanied by different people on the journey to school, and in brackets, the difference between this and on the journey home.

Table 6.8: Proportions of children attending different types of school who were accompanied by various types of people while travelling to and from surveyed schools in the Sheffield study area.

School type and year	Accompaniment					Base
	Alone	Friends	Younger children	Older People	Other/ Unknown	
First:						
1st year	3.1 (+1.5)	7.7 (-1.6)	- (-)	89.2 (-)	- (-)	368
2nd year	16.9 (-)	7.6 (+6.3)	1.5 (-1.5)	73.9 (-4.7)	- (-)	368
3rd year	14.6 (+8.7)	24.3 (-1.9)	- (-)	61.1 (-6.8)	- (-)	368
4th year	20.4 (+6.5)	19.4 (-6.5)	- (-)	60.2 (-)	- (-)	368
Total	13.8 (+4.1)	14.8 (-1.0)	0.4 (-0.4)	71.1 (-2.9)	- (-)	1470
Middle*:						
1st year	(42.6)	(46.0)	(-)	(11.5)	(-)	548
2nd year	(32.8)	(56.1)	(-)	(11.1)	(-)	548
3rd year	(30.1)	(59.0)	(-)	(10.8)	(-)	548
4th year	(27.2)	(67.3)	(-)	(5.4)	(-)	548
Total	36.1 (-2.9)	51.5 (+5.6)	0.3 (-0.3)	12.1 (-2.4)	- (-)	2190
Secondary:						
1st year	13.4 (-3.6)	63.5(+22.2)	0.9 (-0.9)	20.5(-15.5)	1.7 (-1.7)	881
2nd year	27.1 (-0.8)	60.9 (+0.8)	0.8 (+0.7)	10.5 (-0.7)	0.8 (-0.1)	881
3rd year	29.1 (-2.5)	61.4 (+8.9)	2.5 (-1.9)	5.1 (-3.8)	1.9 (-0.6)	881
4th year	35.5 (-1.6)	58.1 (+1.6)	2.4 (-2.4)	3.2 (-)	0.8 (+2.4)	881
Total	26.3 (-2.1)	61.0 (+8.4)	1.7 (-1.2)	9.0 (-4.3)	1.3 (-)	3523

The figures show the proportions of pupils accompanied by different people on the journey to school, and in brackets, the difference between this and the journey home.

* No significant differences in accompaniment were found between years within middle schools on the journey to school, and so only the total figures are presented here. The figures in brackets thus represent the real proportion of children accompanied by particular people on the way home, and not the difference between the morning and evening journeys as elsewhere.

Accompaniment of children by older people was highest in the youngest age groups. The proportion of secondary school children accompanied by older people was very much lower in all cases than that of infants/first school children. The proportion of middle/junior school children accompanied by older people fits somewhere between these, though it varied between the study areas which of the other two groups they were nearest to. In the Bristol and Reading areas there were particularly high proportions of infants school children accompanied by older people, compared to the other areas, especially Nelson. However, Nelson also had the highest proportion of secondary school children accompanied by older people. In most cases a smaller proportion of children were accompanied by older people on the journey home in the afternoon than on the journey to school in the morning. This was probably because a greater proportion of the parents of these children were likely to be at work in the afternoon at the end of the school day, than in the mornings when their children went to school.

The proportions of children travelling to and from middle/junior and secondary schools alone were very similar in three of the areas. However, in the Nelson and Sheffield areas appreciably larger proportions of children travelled alone to and from middle/junior schools than to and from secondary schools. The proportions who travelled alone to and from first/infants schools were, in all but the Bradford study area, substantially smaller than was the case in the other types of schools. In all the study areas smaller proportions of secondary school children travelled alone in the afternoon than in the morning, while for the other two school groups, particularly the youngest children, the opposite was often the case.

In each of the areas only a small proportion of children were accompanied by younger people, though for obvious reasons this proportion tended to be greater for older children. There was also a tendency for smaller proportions of children to be accompanied by younger children in the afternoons than in the mornings, though this is perhaps to be expected because children in secondary schools often leave school later in the afternoon than primary school children, and are thus not available to escort the younger children home.

6.2.3 Number of roads crossed. The aim of this section was to highlight any differences in the number of roads crossed by different groups of children. In order to test if such variations existed, data sets for the three types of school in each of the study areas, for both the journeys to and from school, were modelled using GLIM. Three factors were incorporated into each of these models. The school name, year in school, and a third factor, consisting of two levels: (1) the number of children in the sample of surveyed schools; and (2) the number of roads that these children cross to get to or from school. Logarithmic models of this nature can be used to test the consistency of the ratio of the number of children to the number of roads that they cross, between various schools and year groups.

Two values of the number of roads crossed were used in the models. These were the total number of roads crossed on the journeys to and from school (variables 'numin' and 'numout'), and the number of roads crossed within the study areas on the same journeys (variables 'inum' and 'onum'). The former was of more use when travel patterns were compared between the study areas, and between different groups within those areas, while the latter was needed to work out accident risk. The number of roads crossed in different schools and years within schools were regarded as lognormally distributed and the corresponding numbers of children were regarded for this purpose as similarly distributed. For this reason models of the following form were fitted using a normal error structure and an identity link.

$$\ln (n_{ijk}) = a_i + b_j + c_k + d_{jk} + e_{ik} + f_{ij}$$

where i = school name (1=<i=<the number of schools of a particular type within an area).

j = year in school (1=<j=<the number of years within a particular school type).

n_{ij1} = the number of children in the sample of surveyed schools

n_{ij2} = the number of roads crossed by those children

The statistical significance of the variation in the number of roads crossed per child between schools of the same type, and between years within schools of the same type (as shown by a reduction in deviance and in the degrees of freedom left in the model when the interaction terms e_{ik} and d_{jk} respectively were added to the model) was tested by comparison with the F-distribution.

Results showed that for none of the data sets was there a statistically significant variation in the number of roads crossed per child between years within schools of the same type. However, it was found that in a few cases a variation existed in this ratio between different schools of the same type. This was found to be the case only for secondary or middle schools, and never for infants or first schools. This may be because these types of schools attract children from a greater range of distances than infants/first schools, and thus there was more scope for a large variation in the numbers of roads crossed between these schools, than there was from schools whose children mostly came from nearby.

Despite the lack of variation in the number of roads crossed per child between years within schools and between individual schools of a particular type, there were some more appreciable differences in the numbers of roads crossed by children from each of the study areas, and from different types of schools within these areas. Tables 6.9 to 6.13 show these differences in the total number of roads crossed for each of the study areas. The numbers in these tables have been weighted to the level of the individual school populations, and then summed for each of the school type . Figures for the number of roads crossed within the study areas alone will be considered in later sections looking at accident risk.

Table 6.9: The number of roads crossed by children of different age and sex on journeys to and from surveyed schools in the Bradford study area.

School type and sex of child	Number of children	Total number of roads crossed	Average number of roads crossed per child
First*:			
Boys	676 (-4)	1846 (+165)	2.7 (+0.3)
Girls	689 (-)	1938 (+106)	2.8 (+0.2)
Total	1365 (-4)	3784 (+271)	2.8 (+0.2)
Middle:			
Boys	1065 (-)	4198 (+371)	3.9 (+0.4)
Girls	980 (-)	4371 (+439)	4.5 (+0.4)
Total	2045 (-)	8569 (+810)	4.2 (+0.4)
Secondary**:			
Boys	158 (-)	890 (+30)	5.6 (+0.2)
Girls	80 (-)	418 (+44)	5.2 (+0.6)
Total	238 (-)	1308 (+74)	5.5 (+0.3)
Total	3648 (-4)	13661 (+1155)	3.7 (+0.4)

Numbers in brackets show the change between the journeys to and from school.

* Includes 3rd-5th years only.
** Includes 3rd years only.

Table 6.10: The number of roads crossed by children of different age and sex on journeys to and from surveyed schools in the Bristol study area.

School type and sex of child	Number of children	Total number of roads crossed	Average number of roads crossed per child
Infants:			
Boys	410 (-)	899 (+42)	2.2 (+0.1)
Girls	466 (-)	1144 (+27)	2.5 (-)
Total	876 (-)	2043 (+69)	2.3 (+0.1)
Juniors:			
Boys	900 (-)	2161 (+76)	2.4 (+0.1)
Girls	829 (-)	2126 (+61)	2.6 (-)
Total	1729 (-)	4287 (+137)	2.5 (+0.1)
Secondary*:			
Boys	1514 (-)	5139 (+624)	3.4 (+0.4)
Girls	1234 (-)	5716 (+1743)	4.6 (+1.4)
Total	2748 (-)	10855 (+2367)	4.0 (+0.8)
Total	5353 (-)	17185 (+2573)	3.2 (+0.5)

Numbers in brackets show the change between the journeys to and from school.

* Includes 1st-4th years only.

Table 6.11: The number of roads crossed by children of different age and sex on journeys to and from surveyed schools in the Nelson study area.

School type and sex of child	Number of children	Total number of roads crossed	Average number of roads crossed per child
Infants:			
Boys	373 (-)	1021 (-8)	2.7 (-)
Girls	349 (-)	1070 (-13)	3.1 (-0.1)
Total	722 (-)	2091 (-21)	2.9 (-)
Juniors*:			
Boys	382 (-)	1596 (+48)	4.2 (+0.1)
Girls	418 (-)	1696 (-4)	4.5 (-0.1)
Total	800 (-)	3292 (+44)	4.1 (+0.1)
Secondary**:			
Boys	333 (-)	1869 (+142)	5.6 (+0.4)
Girls	315 (-)	1715 (+176)	5.4 (+0.6)
Total	648 (-)	3584 (+318)	5.5 (+0.5)
Total	2170 (-)	8967 (+341)	4.1 (+0.2)

Numbers in brackets show the change between the journeys to and from school.

* Includes 1st and 4th years only.
** Includes 2nd and 4th years only.

Table 6.12: The number of roads crossed by children of different age and sex on journeys to and from surveyed schools in the Reading study area.

School type and sex of child	Number of children	Total number of roads crossed	Average number of roads crossed per child
Infants:			
Boys	693 (-)	1483 (+10)	2.1 (+0.1)
Girls	706 (-)	1456 (+84)	2.1 (+0.1)
Total	1399 (-)	2939 (+94)	2.1 (+0.1)
Juniors:			
Boys	1170 (-)	2476 (+101)	2.1 (+0.1)
Girls	1127 (-)	2200 (+345)	2.0 (+0.3)
Total	2297 (-)	4676 (+446)	2.0 (+0.2)
Secondary:			
Boys	1976 (-)	5971 (-107)	3.0 (-)
Girls	1350 (-)	5470 (+220)	4.1 (+0.1)
Total	3326 (-)	11441 (+113)	3.4 (+0.1)
Total	7022 (-)	19056 (+653)	2.7 (+0.1)

Numbers in brackets show the change between the journeys to and from school.

Table 6.13: The number of roads crossed by children of different age and sex on journeys to and from surveyed schools in the Sheffield study area.

School type and sex of child	Number of children	Total number of roads crossed	Average number of roads crossed per child
First:			
Boys	693 (-)	1850 (+88)	2.7 (+0.1)
Girls	777 (-)	1969 (+157)	2.5 (+0.2)
Total	1470 (-)	3819 (+245)	2.6 (+0.2)
Middle:			
Boys	989 (-)	2699 (+226)	2.7 (+0.3)
Girls	1201 (-)	3588 (+274)	3.0 (+0.2)
Total	2190 (-)	6287 (+500)	2.9 (+0.2)
Secondary*:			
Boys	1796 (-)	5815 (+86)	3.2 (+0.1)
Girls	1727 (-)	5306 (+152)	3.1 (+0.1)
Total	3523 (-)	11121 (+238)	3.2 (-)
Total	7183 (-)	21227 (+983)	3.0 (+0.1)

Numbers in brackets show the change between the journeys to and from school.

* Includes 1st-4th years only.

From these tables it can be seen that there were some differences in the average number of roads crossed between the study areas. Differences of this nature are to be expected because such factors as the density and structure of the road systems, and the nearness of the residential areas to the schools, varied between the study areas. It can be seen that on the way to school children in the Nelson and Bradford study areas crossed the most roads, while children in the Sheffield study area and particularly the Reading study area crossed the least. The same was true on the way home. The Nelson area has a very dense road network, and thus to walk even a short distance required a child to cross several roads. In the Reading and Sheffield areas the road systems were more open, and thus it was to be expected that fewer roads would be crossed. It is also true that in the Bristol, Reading and Sheffield areas smaller proportions of children walked than in the other areas, and thus it is to be expected that the average number of roads crossed per child will be lower, as children who travel by such modes as bus and car, cross fewer roads on foot than children who walk all the way. This fact is shown quite clearly in Table 6.14 and discussed in more detail below.

It can also be seen from Tables 6.9 to 6.13 that there was a difference in the number of roads crossed between the different school types in each area. There was a tendency for secondary school children to cross more roads, on both journeys, than middle/junior, and first/infant school children. In three of the study areas (Bristol, Nelson and Reading) there was relatively little difference between the numbers of roads crossed by children attending infants and junior schools, compared to the difference between these and secondary schools. In the Bradford area there was less of a difference between middle and secondary schools, than between first and middle schools. This could be because in this area there were fewer middle schools than first schools, and they could thus be expected to have wider catchment areas. In the other areas there were about the same number of first/infants schools, as middle/junior schools, and they were very often located on the same sites. In the Sheffield area, unlike the other areas, there was very little evidence of a difference in the number of roads crossed between the different school types. This was possibly because the Sheffield area is more completely residential than any of the others, and made up mainly of council estates, most of which were designed in the same period of time. Therefore, the likely distance which children would have to travel to school could be taken account of in these designs and perhaps minimised. Each estate was designed to have easy access to a school, which is perhaps not the case as much in non-council estates which have often been built piecemeal over a long period of time, or in areas where the two types of housing coexist. It could also be because the Sheffield area is so homogeneous that children may tend just to go to the nearest secondary school, whereas in the more mixed areas the differences between schools may be greater, and parents may see more advantage in sending their children to a more distant school despite the extra journey.

It can be seen from the tables that there was little evidence of a difference in the average number of roads crossed by boys and girls in any of the study areas. This similarity is perhaps unsuprising, as there is no reason to expect that the spatial distribution of the homes of boys and girls about their schools should vary appreciably.

It can also be seen that in total, in all of the study areas, there were on average a greater number of roads crossed by children in the afternoon, on their way home from school, than in the morning on their way to school. This is consistent with the image of the child going straight to school in the morning, but in the evening often making detours to friend's houses or to the shops before going home, though obviously as the differences were so small, by no means all children make such detours every afternoon. This would tie in with evidence in Tables 6.4 to 6.8 which shows that a greater proportion of children went home from school with friends than went to school with friends. On the journey home from school, between 71.6% and 79.5% of the children in the study areas went straight home, between 8.3% and 11.7% went home via the shops, and between 4.6% and 6.8% went home via a friends house.

Table 6.14 shows the average number of road crossings per child for each study area on the journey to school and the journey home by mode of travel.

Table 6.14: The average number of roads crossed by children on journeys to and from surveyed schools by mode of travel and study area.

Mode	Bradford	Bristol	Nelson	Reading	Sheffield
Walked	4.7 (+0.1)	4.2 (+0.4)	5.0 (+0.1)	3.5 (+0.1)	3.3 (+0.1)
Bus	1.9 (+0.1)	3.1 (-0.1)	2.6 (-0.1)	3.0 (-0.3)	2.3 (-)
Car	0.2 (+0.4)	0.4 (-)	0.4 (+0.1)	0.3 (-)	0.2 (-)
Bicycle	0.4 (-0.1)	0.3 (-0.1)	0.7 (-)	0.5 (-0.2)	3.2*(-1.8)
Other	0.4 (+2.0)	0.0 (+2.6)	0.8 (+1.2)	1.2 (+0.5)	0.0 (+3.2)
All modes	3.7 (+0.4)	3.2 (+0.5)	4.1 (+0.2)	2.7 (+0.1)	3.0 (+0.1)

The numbers in brackets show the difference between the journeys to school and the journey home.
* This figure is based on a very small number of respondents.

It can clearly be seen from this that there are differences in the average number of roads crossed by children using different modes of travel, and that these differences are very consistent between the different study areas. In all cases, children who walk all the way to and from school cross more roads on foot than children using any other mode of travel. It is also always the case that children who travel by bus cross more roads on foot at the beginning, during and at the end of their journeys than children who travel by car. Children who travel by car cross virtually no roads on foot at all, which is consistent with car journeys beginning from outside the child's home, and ending very close to their school, in a lot of cases directly outside.

6.2.4 Distance walked. In the same manner as in the previous section, the data for the distance walked by children to and from school, for each different school and year group, and for each of the study areas, was modelled using GLIM. The aim of this was to assess whether there were any statistically significant differences in the distance walked by children in different year groups of schools of the same type. If no such differences were found, then the survey data for each school could be weighted to the level of the school populations, and then summed for each of the school types and study areas as a whole, without fear of bias.

Similar types of models to those used in the previous section were used here. Again three factors were incorporated into the models used for each of the data sets. These were the name of the school, the year in school, and a third factor consisting of two levels: (1) the number of children in the sample of surveyed schools; and (2) the distance that these children walked. Logarithmic models of this nature can be used to test the consistency of the ratio of the number of children to the distance that they walked, between different schools of the same type, and between years within those schools.

As was the case with the number of roads crossed, two values of the distance walked were used for each of the data sets described above. These were firstly the total distance walked by each child, and secondly the distance walked by each child within the boundaries of the study areas.

The distance walked in different schools and years within schools were regarded as lognormally distributed, and the corresponding numbers of children were regarded for this purpose as similarly distributed. For this reason models of the following form were fitted using a normal error structure and an identity link.

$$\ln(n_{ijk}) = a_i + b_j + c_k + d_{jk} + e_{ik} + f_{ij}$$

where i = the school name (1=<i=<the number of schools of a particular type within an area).

j = year in school (1=<j=<the number of years within a particular school type).

n_{ij1} = the number of children in the sample of surveyed schools.

n_{ij2} = the distance walked by these children.

The statistical significance of the variation in the distance travelled per child between schools of the same type, and between years within schools of the same type (as shown by a reduction in deviance and in the degrees of freedom left in the model when the interaction terms e_{ik} and d_{jk} respectively were fitted to the model) was tested by comparison with the F-distribution.

Results showed that for none of the data sets was there a statistically significant variation in the distance walked per child between years within schools of the same type. Nor were any statistically significant variations found in any of the data sets in the distance walked per child between schools of the same type.

Tables 6.15 to 6.19 show the variation in the distance walked by children of each sex, between types of school, and in each of the study areas, for both of the journeys to and from school. These tables relate to the total distance walked by children. Account will be taken of the distance walked in the study areas in later analyses of accident risk.

These tables show that there were large differences in the total number of kilometres walked between the 5 study areas, but that the average distance walked per child in four out of the five study areas was very similar, both on the journeys to and from school. In the Nelson area the average distance walked per child on the journeys to and from school was shorter than in the other areas. Within each of the study areas children attending secondary schools walked appreciably further than those attending primary schools. This is not suprising as there were fewer secondary schools than primary schools, and they thus had wider catchment areas. There was less of a difference between the average distances walked by children from first/infant schools, and those from middle/junior schools. There was little evidence of any appreciable differences between the average distances walked by boys and girls on the journeys to and from school, though for the reasons outlined in the previous section, this is unsurprising. Finally, in each of the areas, the average distance walked per child was slightly greater on the journey home from school compared to the journey to school. This is perhaps linked to the fact that a greater proportion of children walk on the way home from school than on the way to school, and that it is to be expected that the average distance walked by a child who walks all the way to or from school would be greater than that of a child who travels part of the way by bus, car or some other mode. This fact is shown quite clearly in Table 6.20 and discussed in more detail below.

Table 6.20 shows the average distance walked per child for each study area on the journey to school and the journey home by mode of travel. It can be seen from this that there are differences in the average distance walked by children using different modes of travel, and that these differences are very consistent between the study areas. In all cases children who walk all the way to and from school walk a greater distance than children who travel by other modes for a portion of their journey. It is also true in all cases that children who travel by bus walk a greater distance either at the beginning, during or at the end of their journey than children who travel by car. These figures back up the ideas discussed in the previous section on the number of roads crossed, as they show that children who are taken to or from school by car never walk more than a very short distance either at the beginning, during or the end of their journeys.

Table 6.15: The distance walked by children of different age and sex on journeys to and from surveyed schools in the Bradford study area.

School type and sex of child	Number of children	Total distance walked (km)	Average distance walked per child (km)
First*:			
Boys	662 (-8)	297 (+20)	0.45 (+0.03)
Girls	670 (+2)	306 (+18)	0.46 (+0.02)
Total	1332 (-6)	604 (+38)	0.45 (+0.03)
Middle:			
Boys	979 (-37)	583 (+29)	0.60 (+0.05)
Girls	899 (-)	623 (+62)	0.69 (+0.07)
Total	1878 (-38)	1206 (+92)	0.64 (+0.07)
Secondary**			
Boys	140 (-)	153 (+3)	1.09 (0.02)
Girls	74 (-)	73 (+4)	0.99 (+0.05)
Total	214 (-)	226 (+7)	1.06 (+0.03)
Total	3424 (-44)	2035 (+136)	0.59 (+0.05)

Numbers in brackets show the change between the journeys to and from school.

* Includes 3rd-5th years only.
** Includes 3rd years only.

Table 6.16: The distance walked by children of different age and sex on journeys to and from surveyed schools in the Bristol study area.

School type and sex of child	Number of children	Total distance walked (km)	Average distance walked per child (km)
Infant:			
Boys	397 (+3)	150 (+9)	0.38 (+0.02)
Girls	460 (-)	188 (+12)	0.41 (+0.02)
Total	857 (+3)	337 (+22)	0.39 (+0.03)
Junior:			
Boys	872 (-5)	375 (+15)	0.43 (+0.02)
Girls	813 (-1)	360 (+25)	0.44 (+0.03)
Total	1685 (-6)	735 (+40)	0.44 (+0.02)
Secondary*:			
Boys	1310 (-52)	873 (+25)	0.67 (+0.04)
Girls	1008 (-36)	881 (+159)	0.87 (+0.20)
Total	2318 (-88)	1754 (+244)	0.76 (+0.14)
Total	4860 (-91)	2826 (+306)	0.58 (+0.08)

Numbers in brackets show the change between the journeys to and from school.

* Includes 1st-4th years only.

Table 6.17: The distance walked by children of different age and sex on journeys to and from surveyed schools in the Nelson study area.

School type and sex of child	Number of children	Total distance walked (km)	Average distance walked per child (km)
Infant:			
Boys	371 (-)	124 (-2)	0.33 (-)
Girls	349 (-)	115 (+5)	0.33 (+0.01)
Total	720 (-)	239 (+3)	0.33 (+0.01)
Junior*:			
Boys	380 (-2)	155 (+10)	0.41 (+0.03)
Girls	418 (-3)	175 (-4)	0.42 (-0.01)
Total	798 (-5)	330 (+6)	0.41 (+0.01)
Secondary**			
Boys	277 (-10)	234 (+21)	0.84 (+0.12)
Girls	244 (-1)	197 (+29)	0.81 (+0.12)
Total	521 (-11)	430 (+51)	0.83 (+0.11)
Total	2039 (-16)	1000 (+60)	0.49 (+0.03)

Numbers in brackets show the change between the journeys to and from school.

* Includes 1st and 4th years only.
** Includes 2nd and 4th years only.

Table 6.18: The distance walked by children of different age and sex on journeys to and from surveyed schools in the Reading study area.

School type and sex of child	Number of children	Total distance walked (km)	Average distance walked per child (km)
Infant:			
Boys	691 (-3)	288 (+4)	0.42 (-)
Girls	695 (+3)	286 (+30)	0.41 (+0.04)
Total	1386 (-)	574 (+34)	0.41 (+0.03)
Junior:			
Boys	1158 (+7)	527 (+30)	0.46 (+0.02)
Girls	1096 (+1)	439 (+69)	0.40 (+0.06)
Total	2254 (+8)	965 (+98)	0.43 (+0.04)
Secondary:			
Boys	1434 (-14)	1249 (-24)	0.87 (-0.01)
Girls	1032 (+13)	1001 (+150)	0.97 (+0.13)
Total	2466 (-1)	2250 (+126)	0.91 (+0.05)
Total	6106 (+7)	3789 (+258)	0.62 (+0.04)

Numbers in brackets show the change between the journeys to and from school.

Table 6.19: The distance walked by children of different age and sex on journeys to and from surveyed schools in the Sheffield study area.

School type and sex of child	Number of children	Total distance walked (km)	Average distance walked per child (km)
First:			
Boys	693 (-)	372 (+30)	0.54 (+0.04)
Girls	773 (-)	370 (+41)	0.48 (+0.05)
Total	1466 (-)	742 (+71)	0.51 (+0.04)
Middle:			
Boys	988 (-)	489 (+49)	0.49 (+0.05)
Girls	1197 (-)	637 (+47)	0.53 (+0.04)
Total	2185 (-)	1126 (+96)	0.52 (+0.04)
Secondary*:			
Boys	1689 (-)	1048 (+4)	0.62 (-)
Girls	1615 (-)	1023 (+21)	0.63 (+0.02)
Total	3304 (-)	2071 (+24)	0.63 (-)
Total	6955 (-)	3939 (+191)	0.57 (+0.02)

Numbers in brackets show the change between the journeys to and from school.

* Includes 1st-4th years only.

Table 6.20: The average distance walked by children to and from surveyed schools by mode of travel and study area.

Mode	Bradford	Bristol	Nelson	Reading	Sheffield
Walked	0.72 (+0.02)	0.78 (+0.04)	0.58 (+0.03)	0.82 (+0.03)	0.65 (+0.02)
Bus	0.28 (-0.01)	0.46 (+0.16)	0.28 (+0.02)	0.68 (+0.01)	0.40 (-0.02)
Car	0.01 (+0.06)	0.04 (-)	0.04 (-0.01)	0.01 (+0.01)	0.02 (-)
Bicycle	0.02 (-)	0.01 (+0.01)	0.00 (+0.05)	0.06 (-0.02)	0.35*(-0.19)
Other	0.06 (+0.24)	0.00 (+0.57)	0.01 (-0.01)	0.00 (+0.04)	0.00 (+0.22)
All modes	0.59 (+0.05)	0.58 (+0.08)	0.49 (+0.03)	0.62 (+0.04)	0.57 (+0.02)

The numbers in brackets show the difference between the journey to school and the journey home.
* This figure is based upon a small number of respondents.

Figures 6.1 to 6.5 show the number of children living in certain Enumeration Districts (ED's) in and around the Bristol study area who travelled to selected schools within that area. The number of children sampled at the selected schools has been weighted up to the level of the school population. Five schools were chosen for the different types of patterns that they illustrate. Essentially the shaded part of each diagram represents the catchment area of that school. Figure 6.1 shows the number of children living in each ED who attend Embleton Infants School. It can be seen from this that the maximum distance travelled to and from this school was only about 1 kilometre. Most of the children came from areas directly surrounding the school. Figure 6.2 shows the pattern for another infants school, though this time of Roman Catholic denomination. It can be seen that this had a very wide catchment area, and that relatively few children came from areas closely surrounding the school. The pattern shows that there were small numbers of children coming from a lot of areas. Figures 6.3 and 6.4 show the pattern for children attending the junior schools on the same sites as the infants schools in Figures 6.1 and 6.2. It can be seen from these that the sorts of patterns discernable were similar to those for the infants schools. Finally, Figure 6.5 shows the locations of the homes of children who attended one of the secondary schools in the area. It can be seen that a large number of children came from areas directly surrounding the school, but that also there were sizeable numbers who came from much further afield, and that a few children travelled quite long distances each day.

Figure 6.1: Location of origin of journeys by children to Embleton Infants School, Bristol

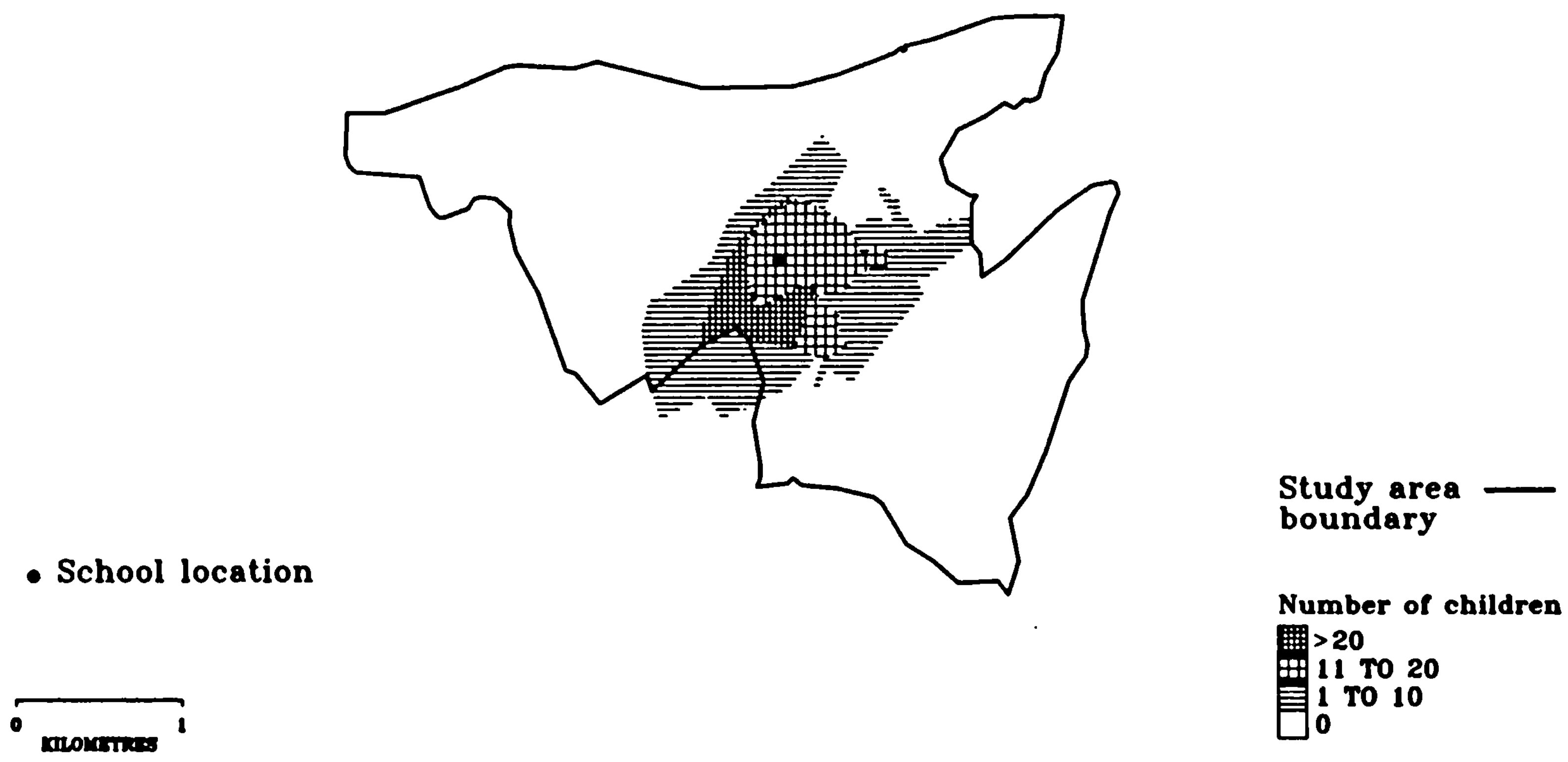


Figure 6.2: Location of origin of journeys by children to St Teresas Infants School, Bristol

Figure 6.3: Location of origin of journeys by children to Embleton Junior School, Bristol

Figure 6.4: Location of origin of journeys by children to St Teresas Junior School, Bristol

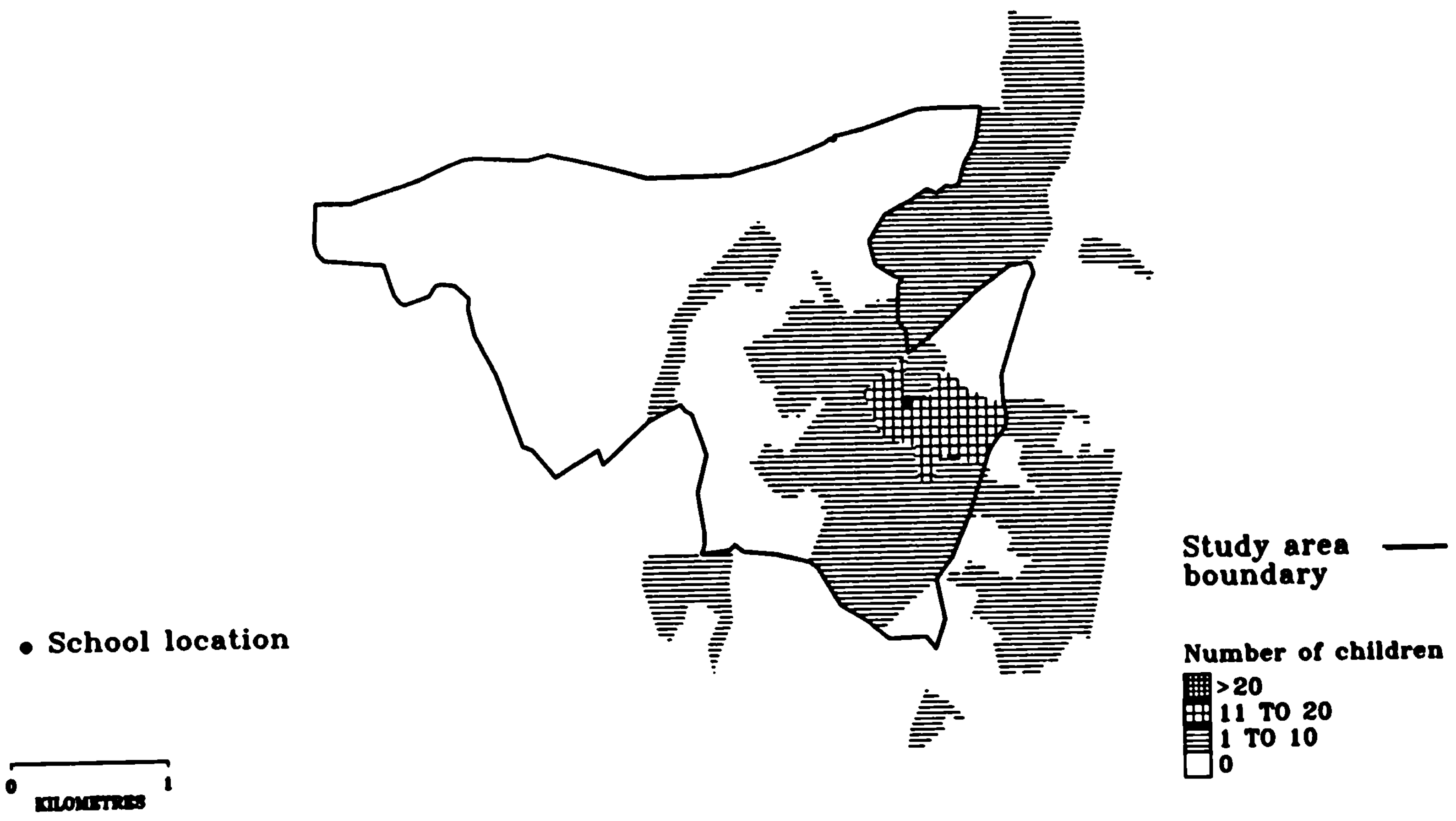
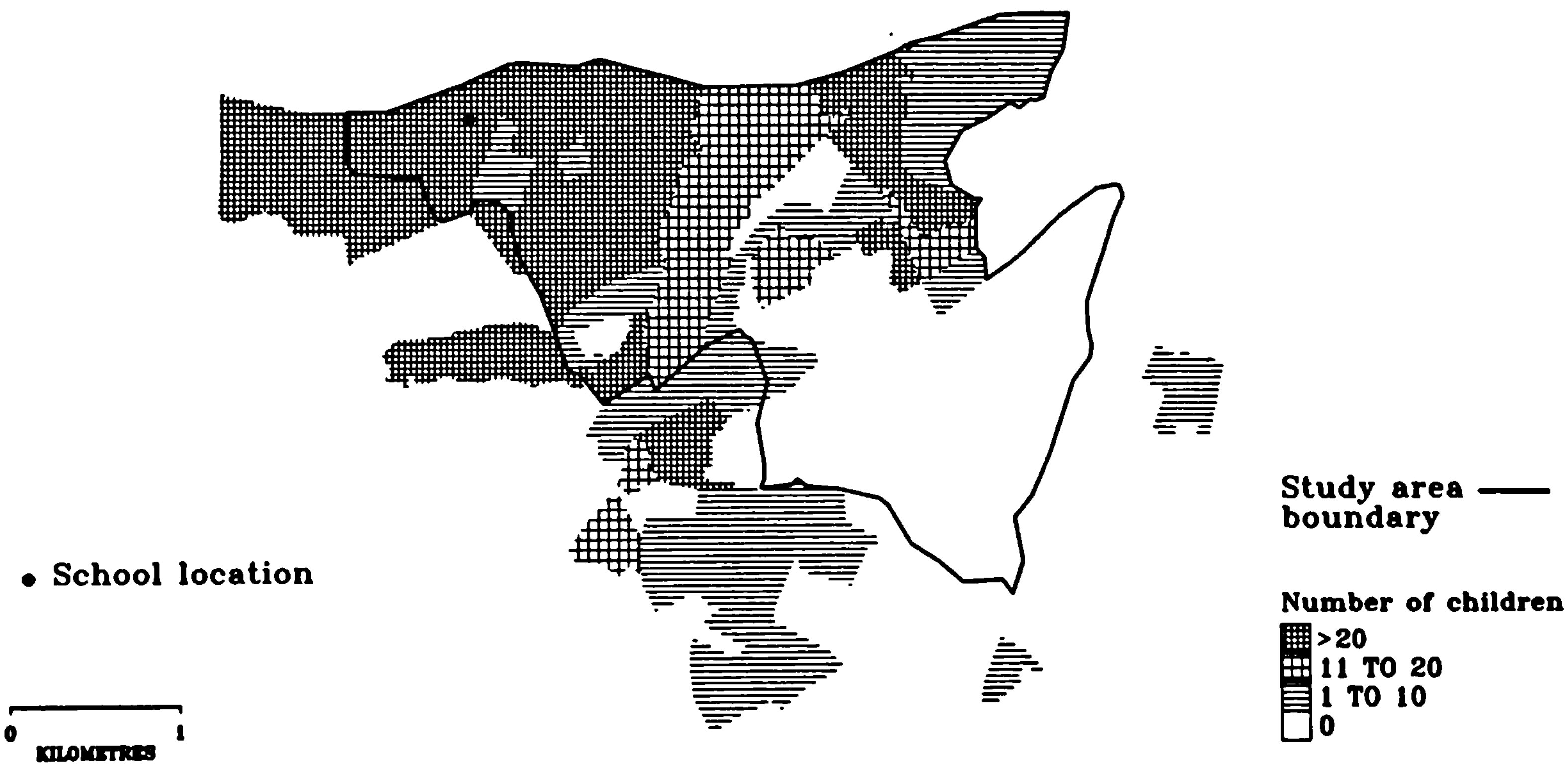


Figure 6.5: Location of origin of journeys by children to Henbury Secondary School, Bristol



Figures 6.6 to 6.8 show similar types of patterns at a first, middle, and secondary school in the Sheffield study area. The only difference between these and the previous diagrams appears to be that the secondary school did not have as wide a catchment area in this study area as the one shown in Figure 6.5 for the Bristol area. This could possibly be because of the close proximity of other secondary schools, and the restrictions that these imposed upon the catchment area of this school. It could also be because the Sheffield area is relatively homogeneous, and that children may tend just to go to the nearest secondary school, whereas in more mixed areas the differences between schools may be perceived to be greater and parents may see more advantages in sending their children to a more distant school despite the extra journey. In this context the Sheffield area is to some extent the odd one out, and the Bristol area is more representative of the areas other than Sheffield.

Figure 6.6: Location of origin of journeys by children to Southey Green First School, Sheffield

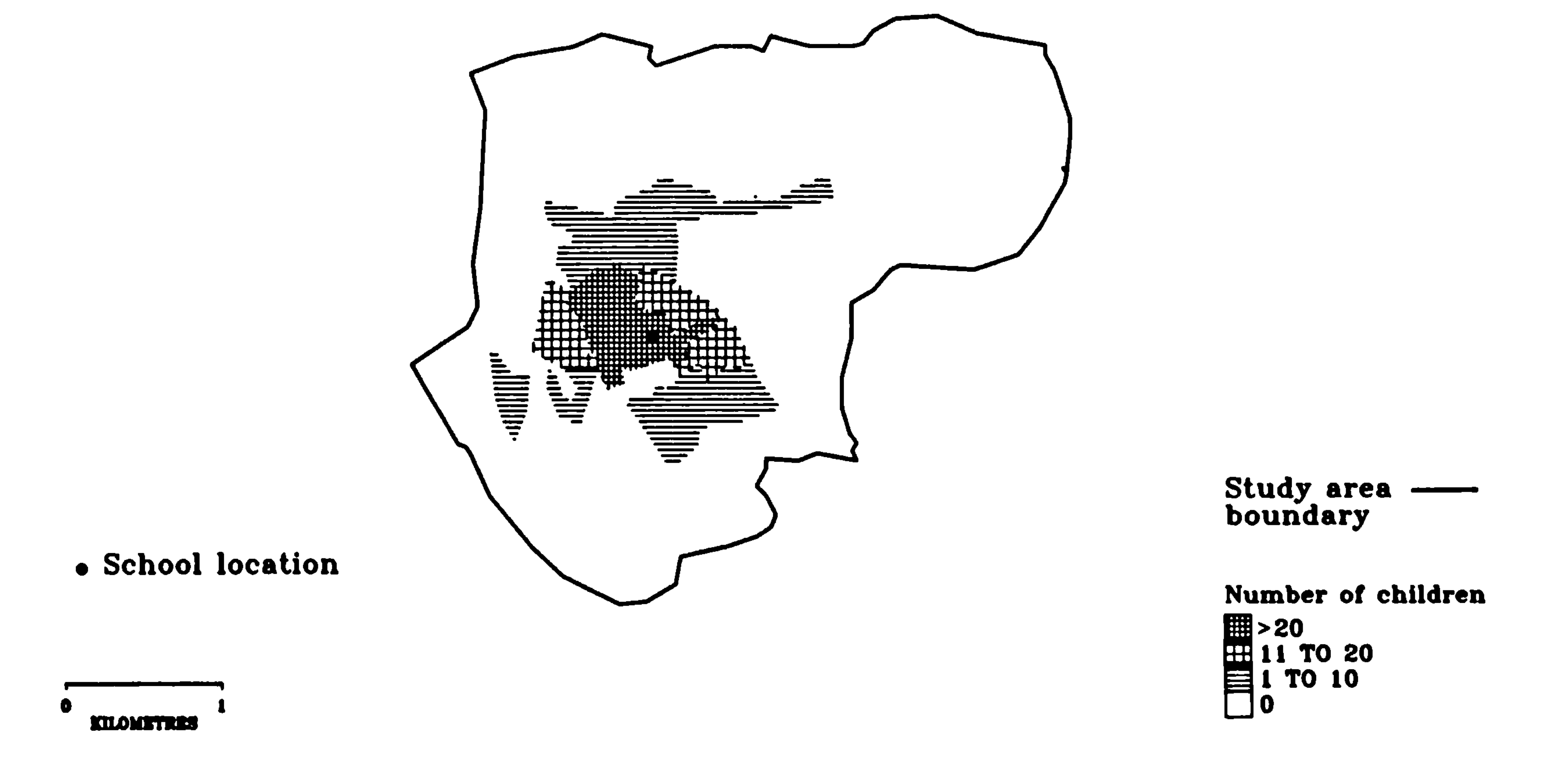


Figure 6.7: Location of origin of journeys by children to Southey Green Middle School, Sheffield

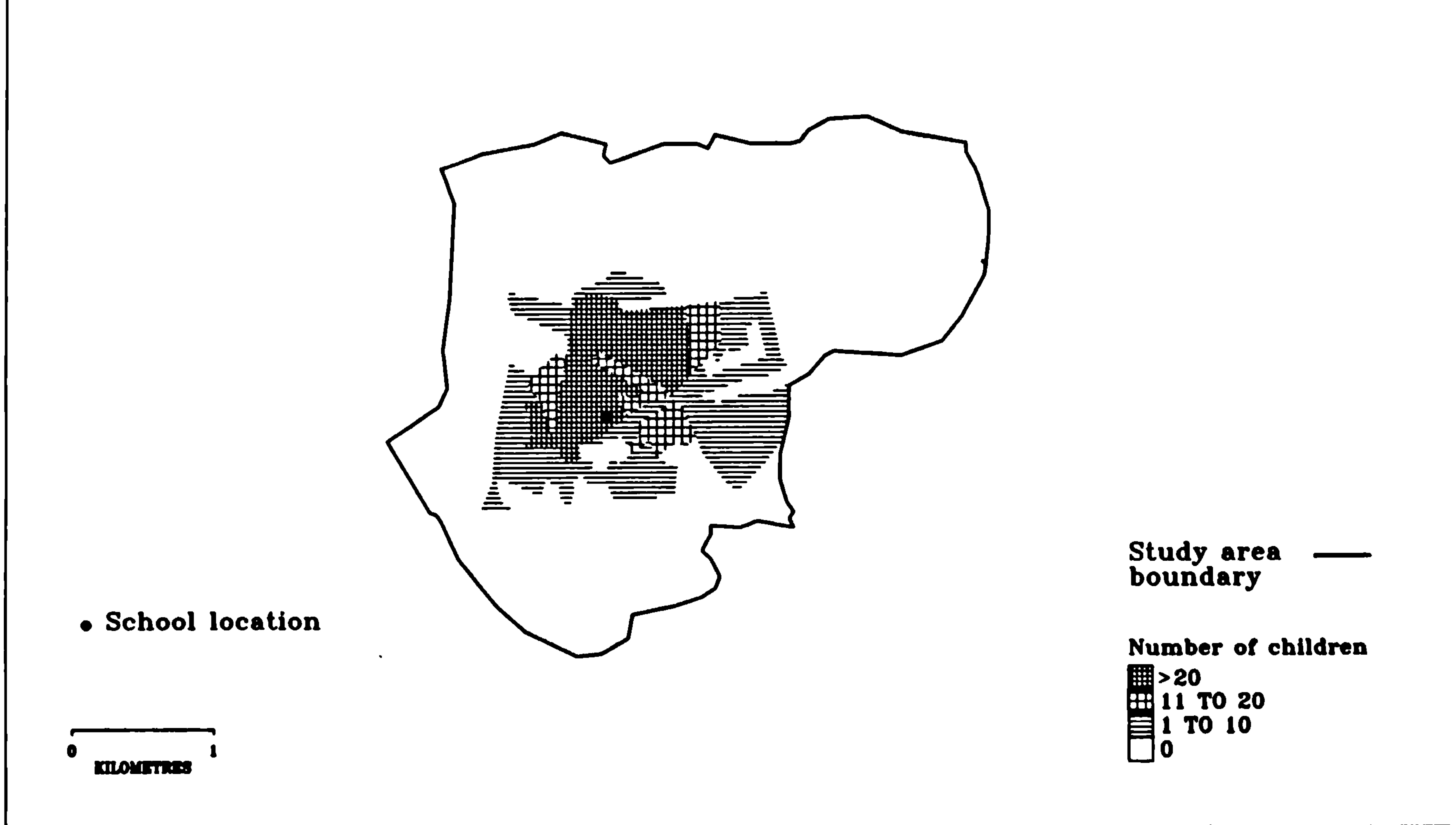
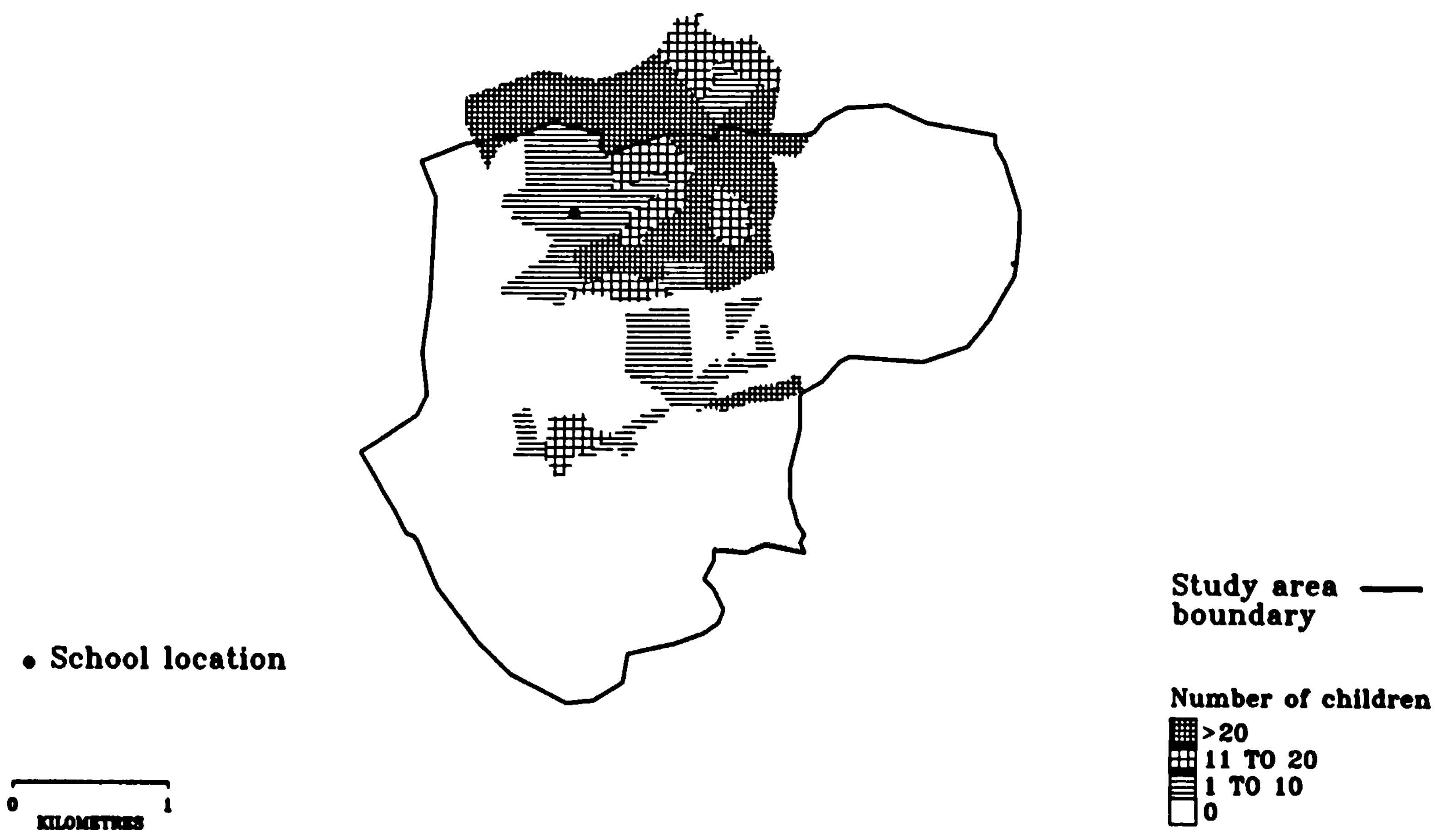


Figure 6.8: Location of origin of journeys by children to Colley Secondary School, Sheffield



6.2.5 Time taken. In the same manner as for the previous two sections, the data on the time taken by children to travel to and from school, for each different school and year group, and for each of the study areas, was modelled using GLIM. The aim of this was to assess whether there were any statistically significant differences in the time taken by children in different year groups of schools of the same type.

Due to the manner of data collection it was not possible to calculate the exact time spent walking. However, it was possible to give upper and lower limits to this figure. These were firstly the total time taken by all children who walked some distance on their journey. This is an overestimate of the time spent walking as it includes time spent travelling while in cars, buses and other modes of travel. The second measure was the time taken by children who walked all the way to or from school. This is an underestimate of the time spent walking as it does not include the time spent walking by children either at the beginning, during or at the end of a journey by bus, car or any other mode of travel. The distances in Table 6.20 indicate that the latter of these two measures would be the nearer to the true value of time spent walking and for this reason this value was used in the following GLIM analyses. However, in the subsequent tables which include measures of time the range of possible values has been given.

Similar types of models to those used in the previous two sections were used here. Again three factors were incorporated into the models used for each of the data sets. These were the name of the schools, the years within the schools, and a third factor consisting of two levels: (1) the number of children in the sample of surveyed schools; and (2) the time taken by those children who walked all the way to or from school. Logarithmic models of this nature can be used to test the consistency of the ratio of the number of children to the time that they took, between different schools of the same type, and between years within those schools. These models were run using both the total time taken to travel to and from school (variables 'timein' and 'timeout'), and the time taken travelling within the study area (variables 'itime' and 'otime'). The time taken in different schools and years within schools was regarded as lognormally distributed, and the corresponding numbers of children were regarded for this purpose as similarly distributed. For this reason models of the following form were fitted using a normal error structure and an identity link.

$$\ln (n_{ijk}) = a_i + b_j + c_k + d_{jk} + e_{ik} + f_{ij}$$

where i = school name (1=<1=<the number of schools of a particular type within an area).

j = year in school (1=<j=<the number of years within a particular type of school).

n_{ij1} = the number of children in the sample of surveyed schools.

n_{ij2} = the time taken by those children who walked all the way to and from school.

The statistical significance of any variation in the average time taken per child between schools of the same type and between years within schools of the same type (as shown by a reduction in deviance and in the degrees of freedom left in the model when the interaction terms e_{ik} and d_{jk} respectively were added to the model) was tested by comparison with the F-distribution. Results showed that for none of the data sets was there a statistically significant variation in the time taken per child between years within schools of the same type. However, it was found that in a few cases a variation existed in this ratio between schools of the same type. This was found to be the case only for some groups of secondary, middle and junior schools, but never for first or infants schools. A similar type of relationship was found for the variation in the average number of roads crossed between schools of the same type. A possible reason for this was discussed in Section 6.2.3.

Tables 6.21 to 6.25 show the variation in the time taken by children of each sex, between types of school, for each of the study areas, and for both the journeys to and from school. The time used in these tables is the total time taken by children while walking on the journeys to and from school. The time taken by children while walking within the study areas will be considered only in the later analyses of accident risk. The tables give both the maximum estimate and the minimum estimate of the time spent walking.

Table 6.21: The time taken by children of different age and sex in the Bradford study area, on both the journeys to and from surveyed schools.

School type and sex of child	Number of children	Total time taken (minutes)	Average time taken per child (minutes)
First*:			
Boys	670 (-31)	4766 (+212) - 5347 (+427)	7.1 (+0.7) - 8.0 (+1.0)
Girls	688 (-16)	5195 (+299) - 5903 (+125)	7.6 (+0.6) - 8.6 (+0.4)
Total	1358 (-47)	9961 (+511) - 11250 (+552)	7.3 (+0.7) - 8.3 (+0.7)
Middle:			
Boys	1065 (-4)	9332 (+1649) - 11687 (+2538)	8.8 (+1.5) - 11.0 (+2.4)
Girls	975 (-)	10594 (+2024) - 12838 (+2147)	10.9 (+2.0) - 13.2 (+2.2)
Total	2040 (-4)	19926 (+3673) - 24525 (+4685)	9.8 (+1.8) - 12.0 (+2.3)
Secondary**			
Boys	158 (-)	1796 (+278) - 2066 (+248)	11.4 (+1.7) - 13.1 (+1.5)
Girls	80 (-)	878 (+46) - 974 (+80)	11.0 (+0.6) - 12.2 (+1.0)
Total	238 (-)	2674 (+324) - 3040 (+328)	11.2 (+1.4) - 12.8 (+1.4)
Total	3636 (-51)	32561 (+4508) - 38815 (+5565)	9.0 (+1.3) - 10.7 (+1.7)

Numbers in brackets show the change between the journeys to and from school.

The lower estimate of average time is based on the time taken by children who walk all the way to and from school. This is thus an underestimate as it does not include the time spent walking at the beginning and ends of journeys by other modes. The upper estimate is based on the time taken by children who walk some distance on journeys to and from school. This is thus an overestimate as it includes some time spent by children travelling in cars and other vehicles.

* Includes 3rd-5th years only.
** Includes 3rd years only.

Table 6.22: The time taken by children of different age and sex in the Bristol study area, on both the journeys to and from surveyed schools.

School type and sex of child	Number of children	Total time taken (minutes)	Average time taken per child (minutes)
Infants:			
Boys	320 (+6)	1625 (+86) - 2055 (+70)	5.1 (+0.1) - 6.4 (+0.1)
Girls	369 (-)	2036 (+118) - 2371 (+169)	5.5 (+0.3) - 6.4 (+0.5)
Total	689 (+6)	3661 (+204) - 4426 (+239)	5.3 (+0.3) - 6.4 (+0.3)
Juniors:			
Boys	900 (-)	6339 (+881) - 7154 (+1095)	7.0 (+1.0) - 7.9 (+1.3)
Girls	827 (-2)	6200 (+929) - 6823 (+935)	7.5 (+1.1) - 8.3 (+1.1)
Total	1727 (-2)	12539 (+1810) - 13977 (+2030)	7.3 (+1.0) - 8.1 (+1.2)
Secondary*:			
Boys	1514 (-)	12682 (+2113) - 16128 (+3569)	8.4 (+1.4) - 10.7 (+2.3)
Girls	1234 (-)	15470 (+4639) - 19953 (+4869)	12.5 (+3.8) - 16.2 (+3.9)
Total	2748 (-)	28152 (+6752) - 36081 (+8438)	10.2 (+2.5) - 13.1 (+3.1)
Total	5164 (-)	44352 (+8766) - 54484(+10707)	8.6 (+1.7) - 10.6 (+2.0)

Numbers in brackets show the change between the journeys to and from school.

The lower estimate of average time is based on the time taken by children who walk all the way to and from school. This is thus an underestimate as it does not include the time spent walking at the beginning and ends of journeys by other modes. The upper estimate is based on the time taken by children who walk some distance on journeys to and from school. This is thus an overestimate as it includes some time spent by children travelling in cars and other vehicles.

* Includes 1st-4th years only.

Table 6.23: The time taken by children of different age and sex in the Nelson study area, on both the journeys to and from surveyed schools.

School type and sex of child	Number of children	Total time taken (minutes)	Average time taken per child (minutes)
Infants:			
Boys	373 (-)	2688 (-89) - 2922 (+35)	7.2 (-0.2) - 7.8 (+0.1)
Girls	349 (-)	2499 (+64) - 2738 (+109)	7.2 (+0.1) - 7.8 (+0.4)
Total	722 (-)	5187 (-25) - 5660 (+144)	7.2 (-0.1) - 7.8 (+0.2)
Juniors*:			
Boys	380 (-)	2667 (+556) - 3072 (+432)	7.0 (+1.5) - 8.1 (+1.1)
Girls	418 (-)	3132 (+186) - 3578 (+157)	7.5 (+0.4) - 8.6 (+0.3)
Total	798 (-)	5799 (+742) - 6650 (+589)	7.3 (+0.9) - 8.3 (+0.8)
Secondary**			
Boys	330 (-)	3587 (+625) - 5739 (+864)	10.9 (+1.9) - 17.4 (+2.6)
Girls	312 (-)	3319 (+761) - 5162 (+1181)	10.6 (+2.5) - 16.5 (+3.8)
Total	642 (-)	6906 (+1386) - 10901 (+2045)	10.8 (+2.1) - 17.0 (+3.2)
Total	2162 (-)	17892 (+2103) - 23211 (+2778)	8.3 (+0.9) - 10.7 (+1.3)

Numbers in brackets show the change between the journeys to and from school.

The lower estimate of average time is based on the time taken by children who walk all the way to and from school. This is thus an underestimate as it does not include the time spent walking at the beginning and ends of journeys by other modes. The upper estimate is based on the time taken by children who walk some distance on journeys to and from school. This is thus an overestimate as it includes some time spent by children travelling in cars and other vehicles.

* Includes 1st and 4th years only.
** Includes 2nd and 4th years only.

Table 6.24: The time taken by children of different age and sex in the Reading study area, on both the journeys to and from surveyed schools.

School type and sex of child	Number of children	Total time taken (minutes)	Average time taken per child (minutes)
Infants:			
Boys	674 (-2)	4572 (+300) - 4720 (+344)	6.8 (+0.5) - 7.0 (+0.5)
Girls	693 (-)	4458 (+696) - 5031 (+567)	6.4 (+1.0) - 7.3 (+0.8)
Total	1367 (-2)	9030 (+996) - 9751 (+911)	6.6 (+0.7) - 7.1 (+0.7)
Juniors:			
Boys	1159 (+11)	7753 (+1543) - 9012 (+1532)	6.7 (+2.2) - 7.8 (+1.2)
Girls	1126 (-)	6653 (+1724) - 8252 (+1609)	5.9 (+1.5) - 7.3 (+1.3)
Total	2285 (+11)	14406 (+3267) - 17264 (+3141)	6.3 (+1.4) - 7.6 (+1.3)
Secondary:			
Boys	1970 (+2)	15963 (-3) - 38760 (+802)	~~8.1 (-)~~ - 19.7 (+0.4)
Girls	1336 (-)	12735 (+3463) - 28791 (+3159)	9.5 (+2.6) - 21.6 (+2.3)
Total	3306 (+2)	28698 (+3460) - 67551 (+3961)	8.7 (+1.0) - 20.4 (+1.2)
Total	6958 (+11)	52134 (+7723) - 94566 (+8013)	7.5 (+1.1) - 13.6 (+1.1)

Numbers in brackets show the change between the journeys to and from school.

The lower estimate of average time is based on the time taken by children who walk all the way to and from school. This is thus an underestimate as it does not include the time spent walking at the beginning and ends of journeys by other modes. The upper estimate is based on the time taken by children who walk some distance on journeys to and from school. This is thus an overestimate as it includes some time spent by children travelling in cars and other vehicles.

Table 6.25: The time taken by children of different age and sex in the Sheffield study area, on both the journeys to and from surveyed schools.

School type and sex of child	Number of children	Total time taken (minutes)	Average time taken per child (minutes)
First:			
Boys	693 (-)	5520 (+900) - 5892 (+588)	8.0 (+1.3) - 8.5 (+0.9)
Girls	778 (-)	5766 (+1114) - 6408 (+929)	7.4 (+1.4) - 8.2 (+1.2)
Total	1471 (-)	11286 (+2014) - 12300 (+1517)	7.7 (+1.3) - 8.4 (+1.0)
Middle:			
Boys	982 (+7)	7158 (+1532) - 8301 (+1264)	7.3 (+1.5) - 8.5 (+1.2)
Girls	1195 (-)	9763 (+1644) - 11125 (+1523)	8.2 (+1.3) - 9.3 (+1.3)
Total	2177 (+7)	16921 (+3176) - 19426 (+2787)	7.8 (+1.4) - 8.9 (+1.3)
Secondary*:			
Boys	1796 (-6)	11427 (+1272) - 20193 (+1250)	6.4 (+0.7) - 11.2 (+0.8)
Girls	1711 (-)	11181 (+842) - 22901 (+518)	6.5 (+0.5) - 13.4 (+0.3)
Total	3507 (-6)	22608 (+2114) - 43094 (+1768)	6.4 (+0.7) - 12.3 (+0.5)
Total	7155 (+1)	50815 (+7304) - 74820 (+6072)	7.1 (+1.0) - 10.5 (+0.8)

Numbers in brackets show the change between the journeys to and from school.

The lower estimate of average time is based on the time taken by children who walk all the way to and from school. This is thus an underestimate as it does not include the time spent walking at the beginning and ends of journeys by other modes. The upper estimate is based on the time taken by children who walk some distance on journeys to and from school. This is thus an overestimate as it includes some time spent by children travelling in cars and other vehicles.

* Includes 1st-4th years only.

It can be seen from these tables that there was some variation in the average total time spent walking by children on the journeys to and from schools between the study areas. Considering the lower estimate first, the shortest average time taken by children was in the Sheffield area, while children in the Bradford and Bristol study areas took the longest times on both of the journeys. Using the upper estimate the pattern was different with the longest average time taken being by children in the Reading study area, while children in the other four areas took very similar lengths of time. It is possible that the Reading figure is so different because of the large proportion of children there who travel to and from school by car, compared to the other areas, and the possibility that large proportions of such journeys will be spent in the car rather than walking, thus having the effect of pushing up the average time.

It can also be seen that there were differences in the times taken by children attending different types of school. In general children in secondary schools took on average the longest time to travel to and from school. However, in the Sheffield area children in secondary schools took on average less time walking to and from school than children in primary schools, using the lower estimate of time spent walking. Using the upper estimate of time spent walking the opposite was the case. In the Reading study area using the upper estimate of time spent walking children in secondary schools spent on average nearly three times as long walking to and from school as children in primary schools. In most cases the average times taken to travel to and from school were more similar between the two types of primary school (i.e. between infants/first and junior/middle schools) in each of the areas. However, in the Bradford and Bristol areas there were some noticeable differences between the two types of school. In the case of Bradford this could be because in this area, the middle schools were located on separate sites from the first schools, and tended, because there were fewer of them than there were first schools, to attract children from a wider area. The times taken by children travelling to and from middle and secondary schools in the Bradford area were not very different.

It can also be seen that there were some differences in the average times taken by children in the morning and afternoon. For each of the study areas, the time taken in the morning was less than that in the afternoon. This would imply that children either took longer routes on the way home, or that there was a tendency to dawdle more. Reference to Tables 6.15 to 6.19 shows that for each of the study areas children walked slightly further on average on the journey home than on the journey to school. However, the proportion of extra distance travelled on the way home from school compared to the journey to school is always less than the proportion of extra time taken (using both the maximum and minimum estimates) on the journey home compared to the journey to school, so while the extra distance travelled on the journey home to some extent accounts for the extra time taken, it is likely that some of the extra time is also due to dawdling.

Finally, it can be seen, that although there were some differences in the times taken by the different sexes, these were by no means consistent throughout the school types within an area, or between areas for the same school type.

Unlike in the previous two sections, it is not intended in this section to examine the variation of time spent walking with mode of travel. Due to the manner in which data on the time taken was collected, and the necessity to use a range of values for the time spent walking, it would not be possible to produce worthwhile figures in a breakdown by mode. If the lower estimate was used (the time taken by children who walk all the way to and from school) then the figures for all modes but walk, would be zero. If the upper estimate was used (the time taken by all those who walk some distance on a journey to or from school) then the average times taken by modes other than walk would probably be quite high. It is likely that the true time spent walking would be nearer to the lower estimate than the upper estimate, especially for children travelling by car, as most of those journeys took the children from very near their home to very near school, and thus the element of time spent walking was very small. Because of this it is thought that a table of mode of travel by time spent walking, using the data collected would not be very informative.

6.2.6 Lunchtime journeys. As mentioned in the introduction to this chapter, very little information was collected concerning children's exposure to risk at lunchtimes. This was because very few accidents occurred during this period to children while on a journey to or from school (in the 6 years 1979-1984 there were 3 in the Bradford study area, 1 in the Bristol area, 3 in the Nelson area, 1 in the Reading area, and 3 in the Sheffield area), and it was thus not thought worthwhile collecting detailed information. However, two pieces of information were collected which will be discussed here. The first of these concerned the number of children going outside school at lunchtime. It was shown that there were some differences in the proportions of children who went outside school at lunchtime between the study areas. The proportions were 19.2%, 18.0%, 26.5%, 17.6%, and 48.1% in the Bradford, Bristol, Nelson, Reading, and Sheffield areas respectively. It is not known why the Sheffield figure was so much higher than those for the other areas, although it was mainly due to a very large proportion of secondary school age children going outside school at lunchtime (69.9%).

It was also shown that more than half of the children in each area who went out of school at lunchtime went home (85.3%, 77.0%, 67.0%, 64.0%, and 52.8% in the Bradford, Bristol, Nelson, Reading, and Sheffield areas respectively). The next most frequented destination was to the shops. The data showed that a smaller proportion of secondary school children went home than primary school children, and that a larger proportion of secondary school children went to the shops than primary school children.

6.3 Accident risk

This section describes the results of a series of analyses which examined the risk of an accident to children while travelling to and from schools in each of the study areas, at different times of the day, and in different types of location. These analyses involved the combination of some of the exposure measures described above with appropriate accident statistics to produce measures of accident risk. The relationship between the number of accidents, exposure to risk and accident risk is as follows:

Accident Risk = Number of Accidents / Exposure

In order to ensure that the measure of accident risk was absolute, both the accidents and the exposure to risk measure had to relate to the same population of children. This meant that several changes had to be made to both the sample of accidents, and the information on children's exposure to risk for each of the study areas. All of the accidents which occurred to children within the study areas, but while they were travelling to or from schools outside the study areas were removed from the sample. Also removed were accidents to child pedestrians which occurred inside the study areas, while they were travelling to or from schools within the study areas but which, for one reason or another, had not taken part in the questionnaire surveys and were thus not included in the sample of information on children's exposure to risk. In two of the areas (Bradford and Nelson) this could be done easily and accurately as the school which each child attended was marked on the accident report form. For the other three areas the most likely school which the child was attending was estimated. This was done by using the child's home address, the location of the accident, the child's age and sex, direction of movement, time of day, and also some of the ideas of 'typical' journey patterns around each school which had been built up during the analyses of exposure. In this way it was thought that a reasonably good idea could be gained of the school to which or from which the child was travelling at the time of their accident. Finally, accidents which occurred to children on journeys to or from school at lunchtime were removed from the sample, because the questionnaire surveys did not obtain information in as much detail for these journeys as for those in the morning and afternoon. The journey characteristics of children who lived outside the study areas, but who travelled to schools within them had to be adjusted. In particular the measures of the number of roads crossed, the distance walked, and the time taken, were adjusted so that they only included the portion of the child's journey which was inside the study area.

It has had to be assumed throughout these analyses that the exposure to risk data, which was collected over a short period of time, was representative of the types of conditions in effect throughout the 6 year period over which the accident data was collected. For instance it was necessary to assume that the behaviour patterns and background of the sample of children surveyed were similar to that of the children involved in the accidents, despite the fact that the two groups of children were not the same, and that the pattern of location of residence of families with school age children in the study areas had not changed. It also had to be assumed that major changes in the road layout had not occurred over the six years of the study. However, since this was one of the criteria upon which the study areas were selected (see Chapter 3), it was reasonable to assume that such changes would be minimal, and to the knowledge of the author this has been the case. It is perhaps worthwhile noting at this point that since the implementation of the Urban Safety Project schemes in the study areas, which in 4 out of the 5 areas was subsequent to the end of the data collection stage of this present project, major changes in road layout and traffic flow have occurred. In the Reading area, implementation of the project scheme took place in the late summer of 1984 (the final year for which accident data was collected). However, it was thought that any changes in child pedestrian accident patterns brought about by this would have had very little effect upon the overall pattern of accidents to children over the 6 years of the study, and so for the sake of completeness and ease of analysis these accidents were included in this survey.

The schools and the residential areas which serve them, have remained in essentially the same positions relative to each other over the 6 years 1979-1984. Because of this it is thought unlikely that children's journey characteristics would have changed drastically in this period. No changes in the 6 year period in the policies of the schools in the study areas as regards pupils journeys to and from school have come to the author's notice. Nor have there been any major changes in the location or number of crossing patrols in the area that have come to the author's notice. It is not known whether there were any substantial changes in the school populations in each of the areas over the 6 year period, as data is only available for one point in time (for the Bradford area this was 1982/3, while for the other areas it was for April 1982). However, it is possible to get some idea of national trends in school populations, and it is thought likely that these will be reflected to some extent by the schools in the study areas. Between 1979 and 1984 figures for the United Kingdom (CSO,1986 and other years) show that the number of pupils at public sector primary schools fell from 5144 thousand to 4134 thousand (a fall of 19.6%) while the number of secondary school pupils fell from 4643 thousand to 4385 thousand (a fall of 5.6%). If the school populations in the study areas did behave in the same way as the national pattern then it is to be expected that this could have had some effect upon the risk analyses which are described in this chapter. However, as the school population figures for the study areas relate in 4 out of 5 cases to 1982 (towards the middle of the range 1979-1984) then it is thought that this effect will be minimal.

For the purposes of these analyses an average daily number of accidents was calculated. This could then be compared to the daily level of exposure to risk, as defined by each different type of measure. The sample data on exposure to risk for each school which took part in the survey was weighted to the level of its school population, and these were summed for each study area. Not all of the exposure measures were used for all of the types of analyses carried out, either because they were not all relevant, or because the necessary breakdowns could not be obtained from the data. Table 6.26 shows which analyses of accident risk were carried out using each of the exposure to risk measures.

Use of different measures of exposure to risk (in each case as many as possible were used), gave a wider insight into differences in accident risk, than a more limited range of measures. Some of the measures used were better in some respects, or more accurately represented the true situation, than others, though each gave a different contribution to the whole picture of accident risk.

Table 6.26: Types of analysis which were carried out for each of the measures of exposure to risk to produce measures of accident risk.

Types of analysis	Exposure to risk measures*					
	Potential number of walk journeys	Mode	Accompaniment	Number of roads crossed	Distance walked	Time spent walking
Between study areas	yes	yes	yes	yes	yes	yes
Morning/ evening	yes	yes	yes	yes	yes	yes
Sex	yes	yes	yes	yes	yes	yes
Age/ schooltype	yes	yes	yes	yes	yes	yes
Main road/ other road	no	no	no	yes	no	no
Distance from school	no	no	no	yes	yes	no
Crossing facilities/ elsewhere	no	no	no	yes	no	no

* - See text for detailed definition of measures.

The first measure is the maximum potential number of walk journeys to and from school. This is derived by using the population of the surveyed schools, and assuming that each child is available to walk both to and from school. Obviously this measure is limited, as it does not show exactly what proportion of the children did in fact use the roads as pedestrians, or came into conflict with traffic. Because of the unlikelihood of all of the children using the roads as pedestrians, accident risk based on this measure will be an underestimate of the true figures for children who do so. The advantage of this type of measure is its easy availability, as is indicated by the popularity of measures such as 'accidents per 100,000 population' in the literature to date (e.g. DTp.,1984).

The second measure used, described in the table as mode, looks at the number of children who were pedestrians throughout their journeys to and from school. This gives a more accurate reflection of accident risk than the previous measure in that children who travelled all the way on their journeys by car or bus, and who were thus essentially unable to have an accident as a pedestrian except possibly at the very beginning and end of their journey were omitted from this measure of exposure to risk. Unfortunately, some children who travelled by bus, car, bicycle or other modes were pedestrians for an appreciable part of their journey. This measure of exposure to risk did not take account of the risk that these children incurred and therefore overestimates the risk to children who walked all the way to and from school. Nor did it take account of the difference in exposure to risk of those children who were accompanied by adults and those who were not.

It might be that in general children who were accompanied by adults were relatively safer than those who were not. The third exposure to risk measure, described in the table as accompaniment, aimed to take some account of this factor. Only children who walked to and from school unaccompanied by adults (i.e. alone, with friends, or with younger children) were included in this measure. It therefore assumed that accompaniment by adults implied complete safety. This was probably not the case because, for example, Grayson (1975a) has shown that of a sample of child pedestrian accidents in Hampshire, 36%

of those to children aged 0-9 years occurred while they were accompanied by an adult or older child. It was unfortunately not known what proportion of the road accidents in each study area happened to children who were accompanied by adults, and so the risks of an accident to accompanied and unaccompanied children could not be estimated separately. This measure therefore gives an overestimate of the accident risk to children unaccompanied by adults. The previous measure, based upon mode of travel, attributed the same accident risk to all children, whether accompanied by adults or not, and therefore gives a smaller estimate, although still an overestimate of the true accident risk. If it was possible to remove all those accidents which occurred to children while walking at the beginning, during or at the end of a journey by bus, car or some other mode from the sample, then this measure of risk, and the previous one based on mode, would give upper and lower limits of the value of risk to a child while walking to and from school taking account of the element of extra safety due to accompaniment by responsible people.

These first three measures gave reasonable gross estimates of the exposure to risk of children within each f the study areas. However, they all failed to take account of any variations in the journey characteristics of the children involved. That is, journeys could vary in the number of roads crossed, the length, or the time taken. The final three exposure to risk measures aimed to take these into account.

The fourth measure, described in the table as the number of roads crossed, took account of the number of times that a potential conflict with traffic occurred, or the number of occasions when the paths of a child and of vehicular traffic crossed. However, this measure was not directly relevant to accidents which occurred outside of the crossing situation. For instance there may have been occasions when cars mounted the pavement, or perhaps more importantly when children entered the carriageway not intending to cross (for instance when retrieving a ball or stone they were kicking, or to escape the clutches of a friend), and were thus potentially as much at risk as if they were crossing. These latter instances were not recorded in the questionnaire responses.

The final two measures, described in the table as the distance walked and the time spent walking, took some account of these limitations. They assumed in the first case that each child was at risk for the whole of the distance that they walked (including the distance walked at the beginning, during, or at the end of bus, car, bicycle or other mode journeys) on each journey, and in the second case for the whole time spent walking on each journey. In the case of the measure of time a range of values has been given. This is because it is not possible to derive accurately the actual time spent walking for the reasons described in Section 6.2.5. The range of values given show the upper and lower limits of the true value of time spent walking, and thus also of the accident risk per unit of time spent walking. The measures of accident risk based upon distance walked and time spent walking do not define specific instances of risk, as was the case with the measure of risk per road crossing, but rather give an average value of risk over all parts of the journey.

These last three measures also did not take account of other factors which may have had an effect upon safety, such as the accompaniment of the children while on the journeys to and from school, or indeed the relative safety of a crossing situation when the child crossed the road at a crossing facility. Some account of these factors will be taken where possible later in this chapter.

The following sections describe the results obtained from the analyses outlined in Table 6.26.

6.3.1 Differences in accident risk between the study areas. Table 6.27 shows the daily number of accidents in each of the study areas, 6 different measures of exposure to risk for the total population of surveyed schools in each study area for a 'typical day' and, derived from these, 6 different measures of accident risk for each of the study areas.

Perhaps the most striking point of this table, and indeed of most of those which follow, is that the risk of an accident to a child per unit of exposure was extremely small. It can be seen that for the five study areas as a whole, there was only about one accident per 350000 walk journeys made by children to and from schools surveyed in the study areas, or one accident per 1.5 million road crossings on those journeys, or per 270000 kilometres walked, or finally per 4.0 to 5.0 million minutes (7.6 to 9.5 years) spent in the road environment. These measures show that an individual child was unlikely to have an accident throughout their school career, while travelling to and from school.

Table 6.27: The daily number of accidents to child pedestrians in each of the study areas on both the journeys to and from surveyed schools, 6 measures of exposure to risk on the same journeys, and the accident risk based on each of these measures.

Study area	Number of relevant accidents	Number of accidents per day ($x10^3$)**	Exposure to risk measures*						Risk of an accident per unit of exposure ($x10^7$)*					
			1	2	3	4	5	6	1	2	3	4	5	6
Bradford	24	20.8	11066	8716	6284	41977	6576	101787 - 118120	18.8	23.9	33.1	5.0	31.6	1.8 - 2.0
Bristol	19	16.5	12080	8394	6467	33390	6655	103660 - 119514	13.7	19.7	25.5	4.9	24.8	1.4 - 1.6
Nelson	21	18.2	7884	6002	4726	34209	4135	69884 - 84288	23.1	30.3	38.5	5.3	44.0	2.2 - 2.6
Reading	38	33.0	14052	8594	5830	33038	7599	105885 - 142769	23.5	38.4	56.6	10.0	43.4	2.0 - 3.1
Sheffield	39	33.9	16128	11445	9239	39032	8183	111522 - 162354	21.0	29.6	36.7	8.7	41.4	2.1 - 3.0
Total	141	122.4	61210	43151	32546	181646	33148	492738 - 627045	20.0	28.4	37.6	6.7	36.9	2.0 - 2.5

* 1 = The number of children in surveyed schools in the areas who were available to make the journeys to and from school.
2 = Estimated total number of walk journeys to and from surveyed schools each day.
3 = Estimated total number of walk journeys unaccompanied by adults each day.
4 = Estimated total number of road crossings on journeys to and from surveyed schools each day.
5 = Estimated total distance walked on journeys to and from surveyed schools each day (km).
6 = Estimated total time taken while walking on journeys to and from surveyed schools each day (minutes). The reason for the range of values is given in Table 6.21 and in the accompanying text.

** This is derived from the number of accidents in 6 years on journeys to and from surveyed schools, divided by the number of school days in the same period.

It can be seen that there were relatively few relevant accidents in Nelson, compared with the total numbers in Chapter 3. This was because a large number of the accidents on the journeys to and from school in this study area occurred to children attending schools outside the study area. Also Nelson had the largest number of schools who did not respond to the questionnaire survey, and so some of the accidents have also been lost in this way.

The table shows that there was some variation in accident risk between the study areas. The sizes of the differences between areas varied considerably according to the rates used, but the ranking of the study areas in terms of accident risk varied relatively little between the different measures used. For all of the measures, the Bristol area had a lower accident risk than the others. This would appear to have been largely due to the relatively few accidents in this area, as none of the measures of exposure to risk were substantially higher than in the other areas except Nelson. In three out of the six measures of exposure, the Reading area had clearly the highest accident rate. For the other two measures, the number of children and the distance walked, the Reading and Nelson areas had about the same rate, which was clearly higher than in Bradford and Bristol.

Children in Reading had nearly twice as many accidents per road crossing as those in Nelson, and yet had slightly less accidents per kilometre walked. This was because in Nelson many more roads were crossed by children, which was consistent with its very dense network of roads, many of which are very small and hardly used. Children in the Reading study area walked greater distances on average than children in the Nelson area on the journeys to and from school.

This table highlights the importance of using measures of exposure to risk to derive accident risk for the purpose of comparison between areas, rather than simply relying on accident statistics alone, as the rank order of the study areas in terms of the number of accidents was not always the same as their rank order in terms of accident risk. The data showed for example that an initial conclusion, based on the accident statistics alone, that the Sheffield area was the most dangerous, would in fact be false when each of the measures of exposure to risk was taken into account. Moreover, the importance of choosing the appropriate accident rate in any application is emphasised by the fact that the differences between values for different areas were by no means the same for different rates.

6.3.2 Differences in accident risk between the journeys to and from school. Table 6.28 shows the number of accidents per school day on both the journeys to school in the morning and home in the afternoon, 6 different measures of exposure to risk for the same journeys for a 'typical day', and 6 measures of accident risk for each of the journeys and each of the study areas.

Table 6.28: The daily number of accidents to child pedestrians in each of the study areas on the journey to and the journey from surveyed schools, 6 measures of exposure to risk for each of these journeys, and the risk of an accident based on each of these measures.

Study area and period of day	Number of relevant accidents	Number of accidents per day ($x10^3$)**	Exposure to risk measures*						Risk of an accident per unit of exposure ($x10^7$)*					
			1	2	3	4	5	6	1	2	3	4	5	6
Bradford:														
Morning	8	6.9	5533	4286	2998	20280	3196	47821 - 54967	12.5	16.1	23.0	3.4	21.6	1.3 - 1.4
Afternoon	16	13.9	5533	4431	3286	21697	3381	53966 - 63154	25.1	31.4	42.3	6.4	41.1	2.2 - 2.6
Bristol:														
Morning	9	7.8	6040	4074	3083	16018	3146	46790 - 56342	12.9	19.1	25.3	4.9	24.8	1.4 - 1.7
Afternoon	10	8.7	6040	4320	3384	17373	3509	56870 - 63172	14.4	20.1	25.7	5.0	24.8	1.4 - 1.5
Nelson:														
Morning	6	5.2	3942	2951	2297	16738	1969	32980 - 41917	13.2	17.6	22.6	3.1	26.4	1.2 - 1.6
Afternoon	15	13.0	3942	3051	2429	17471	2168	36903 - 42371	33.0	42.6	53.5	7.4	60.0	3.1 - 3.5
Reading:														
Morning	16	13.9	7026	4197	2795	16200	3640	49335 - 75013	19.8	33.1	49.7	8.6	38.2	1.9 - 2.8
Afternoon	22	19.1	7026	4397	3035	16838	3960	56550 - 67756	27.2	43.4	63.9	11.3	48.2	2.8 - 3.4
Sheffield:														
Morning	20	17.4	8064	5603	4464	18950	4013	52019 - 76232	21.6	31.1	39.0	9.2	43.4	2.3 - 3.3
Afternoon	19	16.5	8064	5843	4776	20082	4172	59503 - 86122	20.5	28.2	34.5	8.2	39.5	1.9 - 2.8
Total														
Morning	59	51.2	30605	21111	15637	88186	15964	228945 - 304471	16.7	24.3	32.7	5.8	32.1	1.7 - 2.2
Afternoon	82	71.2	30605	22042	16910	93461	17190	263792 - 322575	23.3	32.3	42.1	7.6	41.4	2.2 - 2.7

* See Table 6.27 for definitions.

** This is derived from the number of accidents in 6 years, on each of the journeys to and from surveyed schools, divided by the number of school days in the same period.

It can be seen that the first measure of exposure, the potential number of walk journeys, was the same for both journeys, and that the values of accident risk for each of the journeys using this measure, therefore simply reflected the number of accidents on each journey.

For all of the study areas together, it can be quite clearly seen that accident risk in the afternoon was appreciably greater than that in the morning. In fact for all of the measures the ratio of the two values of accident risk was very consistent, with children being between 1.2 and 1.4 times more likely to have an accident in the afternoon than in the morning. Because the variance due to sampling error of the exposure figures is likely to be small compared to that of the accident statistics, the significance of the differences in accident risk between morning and afternoon can be tested by examining the standard error of the difference between the total number of accidents in the morning and afternoon. Assuming that the accident statistics are poisson variates, the variance of the difference between the number of accidents in the morning and afternoon is estimated to be 141. The standard error is thus approximately 11.9. Hence, the observed value of the difference (23) is unlikely to be due to chance, being about two times the standard error.

The table shows that there was, however, variation between the study areas in terms of accident risk in the morning compared with that in the afternoon. In four of the areas the accident risk in the afternoon was generally greater than that in the morning, but in the fifth, Sheffield, the opposite was the case with there being a slightly greater accident risk in the morning than in the afternoon. This was a result of there being both slightly more accidents and slightly less exposure in the morning than in the afternoon in this area. However, it can be shown that the differences in the proportions of accidents in the morning and the afternoon in the Sheffield area compared to the proportions of accidents in the morning and afternoon in the other 4 areas combined could easily have arisen by chance (χ^2 with one degree of freedom = 1.97, $p>0.15$). The only other instance where accident risk in the morning was higher than in the afternoon was in the Bristol study area using measure six, the time spent in the road environment. However, for this measure, as for all of the other measures the Bristol area had very similar levels of accident risk in the morning and afternoon. In contrast in the Nelson area children were between 2.2 and 2.5 times as likely to have an accident in the afternoon than in the morning, depending upon which measure was used. Examination of standard error values, using the same method as described above~~, shows that this~~ difference is unlikely to be the result of chance.

In general, the accident risk figures for the morning and afternoon periods reflected very much the pattern of accidents at these two times, because the levels of exposure to risk using each of the measures, were very similar between the mornings and afternoons. It can thus be said that in this instance, a knowledge of exposure to risk did not add much to what was already known, based on accident statistics alone.

Since exposure to risk did not appear to explain the variation in accident patterns between the morning and afternoon journeys, it can be assumed that the variation was to some extent a result of other factors. These could be firstly that children behaved more dangerously on the journey home from school than on the journey to school. No evidence of such an effect has been found by the author in the literature on children's behaviour. However, it is possible that being 'released' from school induces a change in behaviour from that on the journey to school. On the journey to school children arrive in small groups staggered over a period of time, while on the journey home, the whole school is let out together. Possibly being part of such a large group promotes a different type of behaviour.

It was also possible that environmental changes between the morning and afternoon may have affected the numbers of accidents. The higher levels of traffic in the morning may have increased children's awareness of danger, compared to the relatively low levels at about 3.30 to 4.00 pm when they left school. These differences could also be related to the likelihood that in general at the end of the day child pedestrians and drivers would be more tired and less alert than in the morning.

Finally, it was possible that differences in accompaniment between the morning and afternoon journeys affected the pattern of accidents to some extent. It was shown in Tables 6.4 to 6.8 that the proportion of children acompanied by friends was higher on the journey home compared to the journey to school.

6.3.3 Differences in accident risk between boys and girls. Table 6.29 shows the average daily number of accidents to boys and girls in each of the study areas, 6 measures of exposure to risk for a 'typical day', and 6 measures of accident risk derived from these.

Table 6.29: The daily number of accidents to child pedestrians of each sex on both the journeys to and from surveyed schools in each of the study areas, 6 measures of exposure to risk to children of each sex on the same journeys, and the accident risk based on each of these measures.

Study area and sex of child	Number of relevant accidents	Number of accidents per day ($x10^3$)**	Exposure to risk measures*						Risk of an accident per unit of exposure ($x10^7$)*					
			1	2	3	4	5	6	1	2	3	4	5	6
Bradford:														
Boys	15	13.0	5986	4615	3577	22863	3608	54091 - 63323	21.7	28.2	36.3	5.7	36.0	2.1 - 2.4
Girls	9	7.8	5080	4101	2708	19115	2967	47696 - 54800	15.4	19.0	28.8	4.1	26.3	1.4 - 1.6
Bristol:														
Boys	6	5.2	6406	4127	3303	15702	3241	45686 - 53163	8.1	12.6	15.7	3.3	16.0	1.0 - 1.1
Girls	13	11.3	5676	4270	3164	17689	3415	57974 - 66351	19.9	26.5	35.7	6.4	33.1	1.7 - 1.9
Nelson:														
Boys	17	14.8	3946	3020	2442	17521	2117	33950 - 43759	37.5	49.0	60.6	8.4	69.9	3.4 - 4.1
Girls	4	3.5	3940	2982	2284	16689	2020	33933 - 40529	8.9	11.7	15.3	2.1	17.3	0.9 - 1.0
Reading:														
Boys	18	15.6	7686	4596	3299	16666	3994	54732 - 76791	20.3	33.9	47.3	9.4	39.1	2.0 - 2.9
Girls	20	17.4	6366	3998	2531	16372	3608	51153 - 65978	27.3	43.5	68.7	10.6	48.2	2.6 - 3.4
Sheffield:														
Boys	14	12.2	7854	5629	4645	17937	3865	52316 - 69141	15.5	21.7	26.3	6.8	31.6	1.8 - 2.3
Girls	25	21.7	8274	5817	4594	21095	4319	59206 - 93210	26.2	37.3	47.2	10.3	50.2	2.3 - 3.7
Total														
Boys	70	60.8	31878	21987	17266	90689	16825	242775 - 306177	19.1	27.7	35.2	6.7	36.1	2.0 - 2.5
Girls	71	61.6	29336	21168	15281	90960	16329	249962 - 320868	21.0	29.1	40.3	6.8	37.7	1.9 - 2.5

* See Table 6.27 for definitions.

** This is derived from the number of accidents in 6 years, on each of the journeys to and from surveyed schools, divided by the number of school days in the same period.

It can be seen from the table that for all but one of the measures, girls had a slightly higher risk of an accident than boys. However, by using the same reasoning as in the previous section, it can be shown by examination of the standard error of the difference between the number of accidents to boys and girls that this difference could quite easily have arisen by chance.

The table also shows that there were differences in the patterns of accident risk between the study areas. In two of the areas - Nelson and Bradford - for each of the measures, boys had a higher risk of an accident than girls. This as true by a factor of between 1.25 and 1.50 times in the Bradford area, and between 3.95 and 4.25 in the Nelson area. In the other three areas girls had a higher risk of an accident than boys. Examination of standard error values shows that the difference between the numbers of accidents to boys and girls in the Nelson study area is unlikely to be due to chance, though in each of the other areas the difference could have arisen by chance. It can be shown by comparing the proportions of accidents to boys and girls in the Bradford and Nelson areas together, with the proportions of accidents to boys and girls in the other three areas together, that the difference is highly statistically significant (χ^2 with one degree of freedom = 12.2, $p<0.001$). It is not known why these differences occurred, though it is obviously possible to speculate that factors such as children's behaviour, or environmental factors may have differred between the areas, and affected the accident risk.

6.3.4 <u>Differences in accident risk between children attending different school types</u>. In each of the study areas, three types of school were considered. These three types varied between the areas, from first, middle, and secondary schools in the Bradford and Sheffield study areas, to infants, juniors, and secondary schools in the other three areas (see Appendix A.1 for a definition of these school types). Table 6.30 shows the average daily number of accidents to children attending each type of school in each study area, 6 measures of exposure to risk, and the accident risk based upon each of these measures. The total figures in this table combine results from first and infants schools, and middle and junior schools. As these groups contain different age ranges of children these figures ought to be treated with care, but it is thought that they give a general impression of the risk situation at the lower and upper age ranges of the primary school system.

Table 6.30: The daily number of accidents to child pedestrians attending different types of surveyed schools on both the journeys to and from school in each of the study areas, 6 measures of exposure to risk for children at the same types of school and on the same journeys, and the accident risk based on these measures.

Study area and type of school	Number of relevant accidents	Number of accidents per day ($x10^3$)**	Exposure to risk measures*						Risk of an accident per unit of exposure ($x10^7$)*					
			1	2	3	4	5	6	1	2	3	4	5	6
Bradford:														
First	7	6.1	4597	3603	1658	12348	1965	32876 - 36902	13.3	16.9	36.8	4.9	31.0	1.7 - 1.9
Middle	11	9.5	4090	3083	2756	16729	2332	40693 - 49250	23.2	30.8	34.5	5.7	40.7	1.9 - 2.3
Secondary	6	5.2	2380	2030	1870	12900	2280	28219 - 31969	21.8	25.6	27.8	4.0	22.8	1.6 - 1.8
Bristol:														
Infants	1	0.9	1752	1257	335	4066	687	7374 - 8574	5.1	7.2	26.9	2.2	13.1	1.0 - 1.2
Juniors	4	3.5	3458	2754	2128	8298	1470	26074 - 28392	10.1	12.7	16.4	4.2	23.8	1.2 - 1.3
Secondary	14	12.2	6870	4383	4004	21026	4499	70213 - 82548	17.8	27.8	30.5	5.8	27.1	1.5 - 1.7
Nelson:														
Infants	4	3.5	1444	1154	605	4161	481	10348 - 11463	24.2	30.3	57.9	8.4	72.8	3.1 - 3.4
Juniors	9	7.8	3200	2730	2298	13018	1320	24497 - 27262	24.4	28.6	33.9	6.0	59.1	2.9 - 3.2
Secondary	8	6.9	3240	2118	1823	17030	2335	35038 - 45563	21.3	32.6	37.8	4.1	29.6	1.5 - 2.0
Reading:														
Infants	5	4.3	2798	2062	373	5408	1086	17291 - 18588	15.4	20.9	115.3	8.0	39.6	2.3 - 2.5
Juniors	14	12.2	4602	3337	2556	8602	1850	29172 - 34398	26.5	36.6	47.7	14.2	65.9	3.5 - 4.2
Secondary	19	16.5	6652	3195	2901	19028	4664	59422 - 89782	24.8	51.6	56.9	8.7	35.4	1.8 - 2.8
Sheffield:														
First	3	2.6	2940	2602	935	7637	1528	24275 - 25701	8.8	10.0	27.8	3.4	17.0	1.0 - 1.1
Middle	17	14.8	4380	3812	3553	12217	2262	35479 - 39901	33.8	38.8	41.7	12.1	65.4	3.7 - 4.2
Secondary	19	16.5	8808	5031	4751	19178	4395	51768 - 96752	18.7	32.8	34.7	8.6	37.5	1.7 - 3.2
Total														
First/infant	20	17.4	13531	10678	3906	33620	5747	92164 - 101228	12.9	16.3	44.5	5.2	30.3	1.7 - 1.9
Middle/junior	55	47.7	19730	15716	13291	58864	9234	155915 - 179203	24.2	30.4	35.9	8.1	51.7	2.7 - 3.1
Secondary	66	57.3	27950	16757	15349	89162	18173	244660 - 346614	20.5	34.2	37.3	6.4	31.5	1.7 - 2.3

* See Table 6.27 for definitions.

** This is derived from the number of accidents in 6 years on journeys to and from surveyed schools, divided by the number of school days in the same period.

The table shows, using the figures for all of the areas together, that there were some differences in accident risk between children from each different class of school. The significance of these differences can be tested by comparing the observed number of accidents with that which would be expected based upon the distribution of exposure between the classes of school (i.e test the null hypothesis that the number of accidents is proportional to the amount of exposure). Using this method it can be shown that for measures 1, 2 and 5 the differences in accident risk between children from each class of school are unlikely to have arisen by chance (for measures 2 and 5, X^2 with 2 degrees of freedom = 8.9, $p<0.02$, and for measure 1, X^2 with 2 degrees of freedom = 6.2, $p<0.05$). For measures 1 and 5 middle/junior school children have the highest risk of an accident despite being involved in a smaller number of accidents than secondary school children. For measures 1 and 2, first/infants school children have the lowest risk of an accident, while for measure 5 they have about the same level of risk as secondary school children. This might be because they are accompanied by adults more than the older groups of children. Finally, it can also be seen that for measure 2, the risk of an accident per walk journey, children in secondary schools had a higher risk of an accident than children at other types of school. This is accounted for partly by the fact that in general less of them walk and more travel by other modes more than younger children, and that those who do walk have longer walks on average. For each of the other measures the differences in accident risk between children from each class of school could easily have arisen by chance.

As with the other tables it can be seen that the situation in the individual study areas was not always the same as that described above for the total figures. It can be shown that the differences between the study areas in the distribution of accidents to children among the three school groups are not very likely to have arisen by chance (χ^2 with 8 degrees of freedom = 14.31,$p<0.10$).

Using the same method as described above it can be shown for the Sheffield area that the differences in accident risk between children from each class of school for each of the measures of accident risk except measure 3 are unlikely to have arisen by chance ($p<0.05$). In each of these cases in the Sheffield area accident risk is highest for middle school children, followed by secondary school children and least for first school children. It can also be shown that in the Reading area, for measure 3, the differences between accident risk for children from each class of school are not very likely to have arisen by chance (χ^2 with 2 degrees of freedom = 5.0,$p<0.10$). In this case the accident risk for pre-school children is very much higher than for the older age groups. This is because this measure overestimates risk, especially for the younger age group who make relatively few of their journeys unaccompanied in Reading (only about 15%), by its assumption that all children accompanied by adults have a zero risk of an accident, as discussed in Section 6.3. Finally, it can also be shown that for measure 2 in the Bristol area the differences between accident risk for children from each class of school are not very likely to have arisen by chance (χ^2 with 2 degrees of freedom = 4.8,$p<0.10$). In this case secondary school children have a much higher risk of an accident than junior school and especially infant school children. For the other measures of accident risk in the

Reading and Bristol areas, and for all measures in the Bradford and Nelson areas it can be shown that the differences in accident risk between children from each class of school could easily have arisen by chance.

6.3.5 Difference in accident risk between main and other roads.

Table 6.31 shows the risk of an accident to children while crossing main and other roads on journeys to and from school, in each of the study areas. The locations of the main roads are shown in Appendix A.4, Figures 1-5 for each of the study areas. The number of roads crossed was the only measure used in this analysis, as it was not possible to obtain the same breakdowns for any of the others from the questionnaire replies.

Table 6.31: The risk of an accident to child pedestrians per road crossing on main and other roads in each of the five study areas.

Study area and type of road	Number of relevant accidents	Number of accidents per day (x10^3)*	Number of roads crossed per day	Risk of an accident per road crossing (x10^7)
Bradford:				
Main roads	19	16.5	6994	23.6
Other roads	5	4.3	34983	1.2
Bristol:				
Main roads	17	14.8	9096	16.3
Other roads	2	1.7	24294	0.7
Nelson:				
Main roads	14	12.2	7155	17.1
Other roads	7	6.1	27054	2.3
Reading:				
Main roads	28	24.3	9400	25.9
Other roads	10	8.7	23638	3.7
Sheffield:				
Main roads	27	23.4	8100	28.9
Other roads	12	10.4	30932	3.4
Total				
Main roads	105	91.1	40745	22.4
Other roads	36	31.3	140901	2.2

* This is derived from the number of accidents in 6 years, on each of the journeys to and from surveyed schools, divided by the number of school days in the same period.

It can be seen from the table that there were more accidents on main roads than on other roads. Since there were also relatively few crossings of main roads compared to other roads, on journeys to and from school, the risk of an accident on main roads was very much higher in all of the study areas, than the risk of an accident on other roads. Using the total figures children were 10.2 times more likely to have an accident while crossing a main road, than when crossing one of the other roads in the study areas. A check on the range of error of this value can be made by estimating its standard error using equation 6.1 below.

$$\mathrm{Var}\left(\frac{k\,x}{y}\right) \doteqdot \frac{k^2\,x^2}{y^2}\left(\frac{1}{x}+\frac{1}{y}\right) \qquad (6.1)$$

where k is the ratio of exposure on other roads to exposure on main roads

x = the number of accidents on main roads

and y = the number of accidents on other roads

x and y are assumed poisson, with the best estimate of the mean given by the observed values.

As in the previous sections, although k is subject to sampling error this estimate of variance takes no account of the sampling error of the exposure data. This is justified because the sampling error of the accident data is likely to be relatively very large, due to the small size of the sample. The measure of variance given by this equation is thus a minimum estimate. Using the figures for the study areas together it can be shown that the standard error of the ratio of accident risk on main and other roads is about 1.9. Hence the 95 per cent confidence limits value of the ratio are about 6 and 14. This difference between main roads and other roads is so strong that the data are sufficient to establish with a high level of confidence that the difference exists. The estimates of the ratio for the individual study areas range from 7 to 23.

Again this example has shown that use of measures of exposure to risk in combination with accident statistics gives a better representation of relative accident risk, than the consideration of accident statistics alone, which although in this instance indicated that children were more likely to have an accident on main roads, compared to other roads, did not indicate the true magnitude of the difference.

Policies aimed at reducing accidents to schoolchildren on the journeys to and from school would, from this evidence, seem to be profitably aimed at either reducing the number of crossings of main roads (perhaps either by creating catchment areas which mean that children do not have to cross main roads, or by routing children away from them), or by making such crossings safer.

6.3.6 Differences in accident risk with distance from school.

This section was intended to test whether children had a higher risk of an accident in the immediate vicinity of their school (perhaps because of the apparent chaos at 'going home time', and to a lesser extent in the morning, when a large number of children use the roads in a small area in a short space of time), or whether children had a greater risk of an accident further away from their schools (perhaps because children in small groups may be more vulnerable to accidents, than large groups where there is 'safety in numbers' and probably also a greater awareness of the danger and consequent responsibility on the part of drivers).

Table 6.32: Table showing the risk of an accident both close to (within 0.5km) and further away from surveyed schools for each of the study areas.

Study area and distance from schools	Number of relevant accidents	Number of accidents per day ($x10^3$)**	Exposure to* risk measures		Accident risk* per unit of exposure ($x10^7$)	
			1	2	1	2
Bradford:						
>0.5 km	8	6.9	19742	2838	3.5	24.3
<0.5 km	16	13.9	22235	3736	6.3	32.7
Bristol:						
>0.5 km	5	4.3	16443	2966	2.6	14.5
<0.5 km	14	12.2	16947	3689	7.2	33.1
Nelson:						
>0.5 km	4	3.5	15631	1588	2.2	22.0
<0.5 km	17	14.8	18578	2547	8.0	58.1
Reading:						
>0.5 km	11	9.5	16710	3439	5.7	27.6
<0.5 km	27	23.4	16328	4157	14.3	56.3
Sheffield:						
>0.5 km	13	11.3	15723	2490	7.2	45.4
<0.5 km	26	22.6	23309	5694	9.7	39.7
Total						
>0.5 km	41	35.6	84249	13321	4.2	26.7
<0.5 km	100	86.9	97379	19823	8.9	43.8

* 1 - Estimated total number of road crossings on journeys to and from surveyed schools each day.
2 - Estimated total distance walked on journeys to and from surveyed schools each day.

** This is derived from the number of accidents in 6 years, on each of the journeys to and from surveyed schools, divided by the number of school days in the same period.

For the purposes of this study, the distance 0.5km from school was taken as an arbitrary boundary between 'close to' and 'further away' from school. The 0.5km boundary was measured using the actual road distance from each surveyed school on large scale maps. It was only possible to carry out this analysis using two of the exposure measures, the number of roads crossed, and the distance walked. Using the data sets for each area, the number of road crossings and the distance walked by children from surveyed schools within and outside the 0.5km boundary was calculated. Similarly, the number of accidents to children attending each surveyed school within and outside the 0.5km boundary was calculated. Accidents were associated with particular schools using the method described in Section 6.3. Table 6.32 shows these results.

The table shows that for the 5 areas together, the estimated risk of an accident per road crossing more than 0.5km away from schools was just under half as high as nearer to the schools, while the risk of an accident per kilometre travelled was just over half as high more than 0.5km away from schools as it was nearer to them. Using equation (6.1) it is again possible to calculate the standard errors of these values. In this case x is the number of accidents further than 0.5km from schools, y the number of accidents within 0.5km of schools, and k the ratio of the exposure within 0.5km of schools to exposure further than 0.5km from schools. It can thus be shown for the figures for all the study areas together that the standard error of the ratio of accident risk greater than 0.5km from surveyed schools to that within 0.5km of surveyed schools, using the number of roads crossed as the exposure measure is 0.09 and using distance as the exposure measure is 0.11. Hence, the observed values of the ratios (0.47 and 0.61 for the number of roads crossed and distance respectively) are unlikely to differ from unity by chance, the difference from unity being about 6 and 4 times their respective standard errors.

It can be seen that there were also some differences between the study areas in the accident risk within 0.5km of schools relative to that further away. In all except the Sheffield area, the risk using both measures of exposure was estimated to be substantially higher close to the schools than further away. In the Sheffield area, however using the number of accidents per kilometre walked, it can be seen that the risk of an accident was estimated to be higher at distances greater than 0.5km from schools, than it was closer to schools, and using the number of roads crossed, the estimated risk further from schools was much more similar to that close to schools than was the case in the other areas. It is not known why the Sheffield study area is in this respect different from all the rest, but it is interesting to note that the Sheffield area was found in Section 6.2.4 to be the odd one out in terms of catchment areas of its schools.

6.3.7 Accident risk at crossing facilities and elsewhere. For the purposes of these analyses, crossing facilities were defined as school or police crossing patrols, and zebra and pelican crossings. Pedestrian refuges were not included as they do not give the pedestrian right of way to cross a road. Bridges and subways were also ommitted from the list as they imply complete segregation of the pedestrian and traffic, and thus, if they are used the pedestrian has a zero chance of being involved in a road accident. Table 6.33 shows the risk of an accident to children on both the journeys to and from surveyed schools per road crossing using one of the facilities described above, and per road crossing on other main roads, for each of the study areas. Road crossings on side roads were not considerd in this analysis because in every case the crossing facilities in the study areas were on main roads, and thus to consider side road crossings as part of the number of unaided crossings would have produced misleading results.

It can be seen from the total figures that the risk of an accident while crossing a main road at a crossing facility in the study areas, was only about a third that of crossing a main road unaided at some other point. Using Equation (6.1) it is again possible to calculate the standard error of this value. In this case x is the number of accidents at crossing facilities, y the number of accidents elsewhere on main roads, and k the ratio of exposure elsewhere on main roads to exposure at crossing facilities. It can thus be shown for the figures for all the study areas together that the standard error of the ratio of accident risk while crossing a main road using a crossing facility, and the accident risk while crossing a main road elsewhere is about 0.07. Hence, the observed value of the ratio (0.34) is very unlikely to differ from unity by chance, and has 95 per cent confidence limits of about 0.2 and 0.5. In all of the study areas there was a higher estimated risk of an accident while crossing a main road unaided than crossing a main road at a crossing facility, the estimated ratios for the individual areas ranging from about 2 to 6.

Table 6.33: Table showing the risk of an accident to child pedestrians on the journeys to and from surveyed schools when crossing main roads using crossing facilities (aided) and when crossing main roads otherwise (unaided), for each of the study areas.

Study area and type of crossing	Number of relevant accidents	Number of accidents per day ($\times 10^3$)*	Number of roads crossed per day	Risk of an accident per road crossing ($\times 10^7$)
Bradford:				
Aided	4	3.5	4084	8.6
Unaided	15	13.0	2910	44.7
Bristol:				
Aided	5	4.3	3732	11.5
Unaided	12	10.4	5142	20.2
Nelson:				
Aided	4	3.5	3635	9.6
Unaided	10	8.7	3520	24.7
Reading:				
Aided	8	6.9	6384	10.8
Unaided	20	17.4	2689	64.7
Sheffield:				
Aided	13	11.3	5372	21.0
Unaided	14	12.2	2728	44.7
Total				
Aided	34	29.5	23756	12.4
Unaided	71	61.6	16989	36.3

* This is derived from the number of accidents in 6 years, on each of the journeys to and from surveyed schools, divided by the number of school days in the same period.

The table shows that different proportions of main road crossings were made without using crossing facilities in each of the study areas. This ranged from only 29.6% of main road crossings in the Reading area, to as much as 57.9% in the Bristol area. It has already been shown that such crossings have a high risk potential, and from a road safety point of view should be discouraged. These findings indicate either that the provision of crossing facilities, both in terms of number and location with respect to major flows of child pedestrian movement, differs between the areas or that children's behaviour (in terms of whether or not they choose to cross at crossing facilities) differs between the areas. It is considered that the proportions of children crossing main roads using crossing facilities could be increased in all the areas by some kind of schools based training programme, or by the identification of safer routes to school, perhaps along similar sorts of lines as that proposed by Grimshaw and Mathew (1985a to e). This sort of work could, even in the present economic climate, be supplemented where needed by the relatively inexpensive provision of new pedestrian crossings or the resiting of old ones.

6.4 Conclusions

The first part of this chapter examined the variation in the patterns of exposure to risk between the study areas, between types of schools within these areas, between years within schools, between children of the two sexes and between the journeys to and from school. Five measures of exposure to risk were discussed: the mode of travel, accompaniment, the number of roads crossed, the distance walked, and the time spent walking. It was found that with the exception of accompaniment, there was little variation in the measures of exposure to risk between years within schools or between the two sexes of children. However, more substantial variations were found in exposure to risk between children in different types of school, in the different study areas, and on the journeys to and from school.

The second part of this chapter examined the levels of accident risk for each of the study areas as a whole, to different groups of children, at different times of the day, and finally at different types of location within the study areas. The scope of useful results obtained in this chapter was limited to some extent by the small sample of accidents available for each of the study areas. This meant firstly, that it was not possible to produce worthwhile breakdowns of accident risk which involved splitting the accident sample for each area into more than two or three groups, as the likelihood of sampling error affecting the results would be too great. Secondly, it was also shown, even for some of the breakdowns which were carried out, that the differences in accident risk were too small to be able to say with a reasonable degree of certainty that they did not arise as a result of sampling error. However, despite these limitations, some useful results have been obtained. These are especially important because of their implications for road safety policy in the study areas and on a wider scale. A brief outline of the major findings of this section and their implications for road safety policy, in particular the implementation of new road safety measures and educational programmes, is given below.

It was shown that there were some differences in accident risk between the study areas, in particular the Bristol area was found to have a substantially lower accident risk than the other study areas. It is not known why such a difference exists, however, further study perhaps looking at children's behaviour in this study area compared to the others, may well produce some useful and interesting results.

Using figures for all the study areas combined, accident risk in the afternoon was shown to be between 1.2 and 1.4 times as high as accident risk in the morning. In the Nelson area this difference was shown to be greater still. It was thought that this may be in part due to differences in behaviour, in the levels of traffic, in alertness (both of drivers and children) and in accompaniment on the journeys to and from school. These results indicate a need for road safety measures which are particularly effective on the journey home from school. Measures such as extra crossing patrols in the afternoon, speed restrictions near to schools in the going home from school period of the day, or education and training focussed on behaviour on the way home could be especially useful as they would provide extra protection during the period of time when it was most needed.

Examination of differences in accident risk between different age groups of children showed that children in the middle/junior school age range were most at risk. First/infants school children were least at risk, most likely because of the extra degree of protection given to them by adults on journeys to and from school. These results indicate that in terms of increasing road safety the high level of accompaniment by adults on journeys to and from school should be extended, to include not just the very youngest children, but also where possible middle/junior school children. Unfortunately, action of this sort would have other implications, such as a reduction in the freedom of these children, and a greater strain upon parents who would have to be available to take their children to and from school. Because of this, other ways of reducing the high accident risk to the middle/junior school age group should be considered, such as parental and schools based training programmes aimed at creating a better awareness of the dangers of travelling to and from school, and combined with these planning measures to make heavily used routes to school safer. The implementation of such measures should be based upon detailed surveys of the routes that children take to and from schools so that new crossing facilities or educational material aimed at identifying safe routes to schools, would have maximum effectiveness in bringing about a reduction in accident risk.

One of the most striking results found was the difference in accident risk when crossing main roads compared to other roads. For all the study areas together the risk of an accident on main roads was shown to be about 10 times that on other roads. This evidence clearly shows that policies aimed at reducing accident risk to children should be particularly concerned with main roads. This could be done by the creation of catchment areas which are bounded by main roads rather than encompassing them. Where this is not possible, or catchment areas of the latter form already exist, then the identification of safe routes to school, which firstly minimise main road crossings, and secondly ensure that where such crossings are essential they are made at crossing facilities, would help to reduce accident risk. This latter point is supported by evidence from the present survey which shows that the accident risk of crossing a main road not at a crossing facility is about three times the accident risk of crossing a main road at a crossing facility.

Analysis of accident risk close to (within 0.5km) schools showed that this was about twice as high as that further from (greater than 0.5km) schools. This result points towards the need for more crossing facilities close to schools where a large number of crossings are made. It also indicates that some measures should be used to encourage drivers to pay particular attention to the risk of accidents in the vicinity of schools, and to encourage greater awareness among children of risk near to school.

Finally it was shown that the risk of an accident to an individual child on the journeys to and from school was very small using each of the measures of exposure to risk, and that any one child is unlikely to have an accident during their school career. However, the risk of an accident occurring within each school group in the areas is proportionately higher than that of the individual, and the results of this study showed that several of the children attending each of the surveyed schools are likely to be injured in a road accident over a period of a few years. The analyses of accident risk described in this chapter give an indication of ways in which some of these injuries could be prevented. It is thus concluded that the collection of data concerning children's routes to and from school is a necessary supplement to the collection of accident data, and that a knowledge of accident risk is a useful aid to the design and implementation of road safety measures.

CHAPTER 7

A METHOD OF ESTIMATING THE EXPOSURE OF CHILDREN TO RISK WHILE USING THE ROAD FOR REASONS OTHER THAN GOING TO AND FROM SCHOOL

As explained in Chapter 4, it was decided to put the remainder of effort in this particular study into a survey of the exposure of children to risk of a road accident while out of doors for reasons other than going to and from school. It is thought that in most cases this will be while going to and from friends' houses, while running errands of various types, or while outside for the purpose of play. By including activities of these kinds it was felt that the exposure of children for most of the types of use that they make of the roads in their local areas would be covered to some extent, and thus the scope of the study would be greatly increased. A survey of the exposure and activities of children while not travelling to and from school would also take some account of pre-school children who have been left out of the surveys described so far.

It has been shown in Chapter 2 that studies of children's exposure on non-school-related journeys have been far from conclusive in terms of results, and that the methods used to collect the data have often been very time consuming or labour intensive. What seems to be needed is a method that is inexpensive, reliable, can be carried out by a small number of people, but which can also still obtain exposure data for a wide area. The remainder of this chapter describes what is intended to be just such a method.

7.1 The scope of the survey

Restrictions of time and money meant that this survey of children's use of the road system for non-school-related journeys could not be carried out in all of the study areas in the same way as the surveys of journeys to and from school. However it was thought that undertaking a sample survey in some of the areas at a sample of times would provide a good test of the methods involved, and also produce results which, providing the sample had been chosen carefully, would be the basis for valid and useful conclusions. Thus while in one sense these surveys represent a pilot study of the methodology, it is hoped that the results will prove to be both interesting and useful in their own right.

7.1.1 The areas to be studied. The above restrictions meant that only two of the study areas would be included in this survey. These two areas were chosen largely on the basis of a consideration of the background (defined by environmental as well as economic and social conditions), and the accident characteristics of each of the five study areas. In terms of background characteristics it was thought desirable to have two areas which contained a wide range of variation. It was also necessary to choose two areas which contained a high number of accidents which did not occur on a journey to or from school. This was because the fewer accidents there were in the sample, the larger would be the possible effects of sampling error upon the measures of accident risk that were derived. This would be especially the case when more detailed breakdowns of the data were carried out. The fact that the areas were chosen partly on the basis of their accident numbers should, however, be borne in mind in any attempt to generalise from the findings.

The two areas which best fitted these conditions, as well as some other more practical considerations, were Bristol and Nelson. The former has a wide variety of housing types and social groups, containing within it both pre-1945 and post-1945 council estates, and a sizeable proportion of private housing of varying ages. For a more detailed description of the areas see Chapter 3. This area as a whole has comparatively low unemployment levels, though on certain estates these are quite high. The Nelson area is very different from this, being an old mill town, no longer so prosperous and having generally higher levels of unemployment. Most of the houses in the area are in long terraces, most are owner-occupied, and many have small or no front gardens. The Bristol area has a lot of open space, while Nelson has very little in the town itself. The roads in Nelson are based on a grid system, while in Bristol there is more variety with newer layouts being predominant. A lot of the roads in Nelson are cobbled, and therefore possibly to an extent discouraging to cars. There are also a lot of 'back alleys' between rows of terraced houses, rarely used by cars, and possibly attractive to children as play areas.

Table 7.1 shows the numbers of accidents by journey purpose and sex of the child for each of the five study areas. Data are only included for the four years 1979-1982 as this was all that was available at the time of setting up the surveys (Table 3.13 shows the same relationships, but with the six years of data now available.

Some differences between the two tables are apparent, but these mostly reinforce the reasons for the choice of areas which are described below).

Table 7.1: Accidents by journey purpose and sex of child for each of the study areas for the years 1979-1982 (all figures except the base are percentages).

Journey purpose and sex	Area					All areas
	Bradford	Bristol	Nelson	Reading	Sheffield	
Accidents to school age children:						
On a journey to or from school:						
Males	18.4	3.2	17.9	20.3	12.5	14.9
Females	9.2	9.5	7.1	13.5	17.3	11.4
Total	27.6	12.7	25.0	33.8	29.8	26.3
Not on a journey to or from school:						
Males	32.9	47.5	31.2	31.0	36.5	35.2
Females	25.0	30.2	21.4	23.0	25.0	24.5
Total	57.9	77.7	52.6	54.0	61.5	59.7
Accidents to pre-school children:						
Males	9.2	6.4	14.3	4.1	2.9	7.7
Females	5.3	3.2	6.3	8.1	3.9	5.4
Total	14.5	9.6	20.6	12.2	6.8	13.1
Unknown	0.0	0.0	1.8	0.0	1.9	0.9
Base	76	63	112	74	104	429

This table shows that of the 5 areas, Bristol had the highest proportion of accidents to school-age children not on the journeys to or from school. Although Nelson had the lowest proportion of these accidents, it had the largest proportion of accidents to pre-school children, and the second largest proportion of accidents other than on a journey to or from school.

7.1.2 The times of study. There are three times when it would appear likely that usage of the streets by children for purposes other than going to and from school would be at a maximum. These are firstly on school holidays, secondly at weekends, and thirdly after school on schooldays. For ~~the~~ reasons explained above, it was not possible to cover all of these times in the surveys in both areas. The choice of periods to survey was based upon the following. It was considered necessary to choose them in such a way that comparisons would be possible both between different time periods within an area, and also between areas for the same time period, and resources permitted only a limited number of separate visits to each area. For this reason it was decided not to survey at weekends, but rather just on 5 successive weekdays during school holidays, and 5 successive weekdays during termtime. Surveying at weekends would also mean using a different pattern of data collection to surveying over a 5 day period (see Section 7.3 for further explanation), and would require several separate weekend visits to obtain a similar amount of data as on weekdays, even if Saturday and Sunday could be regarded as being as similar as different weekdays, which is far from being the case. Table 7.2 shows the proportions of accidents not on journeys to or from school in each of the two areas, at different times of the day, on different kinds of day, to both school age children, and pre-school children.

Both data for the period 1979-1982, and 1983-1984 are shown in this table. The former because this was the data available at the time of setting up the surveys, the latter because unlike Table 7.1, the 6 year information is not available elsewhere in the thesis (in general the extra data for 1983-1984 added since the surveys were undertaken reinforces the reasons for the selection of survey times which are described below). In both of the areas there were more accidents on weekdays in termtime than on weekdays in the school holidays. In the Nelson area this is also true if the number of accidents per 100 days of each of these periods is considered (see Table 3.10). However, in the Bristol area there are about the same number of accidents per 100 days on holiday weekdays as on termtime weekdays (though it should be remembered that this latter figure includes accidents on journeys to and from school).

Other studies have shown that the total number of children using the roads per day on weekends in school holidays is similar to that on weekdays in school holidays. Although there are differences between these periods in the distribution of usage over the day, no such differences were found in the distribution of age and sex, patterns of accompaniment, location, movement, or activity (Knighting et al,1972). If this is assumed also to be the case in the two study areas, then within the limitations of this assumption the accidents on weekdays and weekends in the school holidays can be taken together for the purposes of analysis of accident risk over the whole day. Reference to Table 3.10 shows that in both the areas the number of accidents per 100 days on holiday weekends and holiday weekdays are very similar, and the numbers in Table 7.2 are not inconsistent with a broadly similar distribution of accidents over the two kinds of day.

Table 7.2: Accidents to child pedestrians not on journeys to and from school in certain periods of the day and school year in the Bristol and Nelson study areas.

	Bristol								Nelson							
	Holiday				Termtime				Holiday				Termtime			
	weekdays		weekends		weekdays		weekends		weekdays		weekends		weekdays		weekends	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Before 9am	-	-	-	-	-	-(1)	-	-	-	-	-	-	-	-	-	-
9-12am	-(1)	-	-	-(1)	-	-	-	3(-)	1(-)	1(1)	-	-(1)	3(-)	-(2)	-(1)	2(1)
12-2pm	1(1)	2(3)	-	1(-)	1(-)	-(1)	1(-)	6(-)	1(-)	4(2)	-	-(2)	3(2)	4(1)	-	3(2)
2-5pm	1(-)	2(1)	-	1(3)	-	12(1)	1(-)	3(3)	2(1)	4(2)	1(-)	2(2)	4(-)	6(13)	-(1)	4(1)
5-8pm	-	3(-)	-	3(1)	1(1)	9(3)	-	2(-)	1(-)	1(-)	1(1)	2(2)	4(4)	24(11)	1(1)	1(-)
After 8pm	-	1(1)	-	-	-	1(-)	-	-	-(1)	1(1)	-	-	-	-	1(-)	-
Total	2(2)	8(5)	-	5(5)	2(1)	22(6)	2(-)	14(3)	5(2)	11(6)	2(1)	4(7)	14(6)	34(27)	2(3)	10(4)

a - Accidents to pre-school age children b - Accidents to school age children

Numbers in the table refer to the 1979-1982 figures. The numbers in brackets refer to the 1983-1984 figures. The sum of the two for each entry is the 6 year total of accidents from 1979-1984.

The first survey was carried out in Nelson during five weekdays in the school summer holiday in 1984 (from the 30th July to 3rd August). It was thought that this would identify levels of exposure towards the upper end of the range of those likely to be encountered on any of the school holidays, due to the generally better weather conditions and longer days in the summer.

The second survey was carried out in the Bristol area, again over 5 weekdays in the school summer holidays in 1984 (from the 13th to the 17th August). It was thought that this would enable comparisons with the Nelson school holiday survey to be made, to try to identify if any differences exist in exposure and risk patterns in the two different types of area.

The third survey was again in Nelson, but carried out in a week during schooltime (from the 20th to the 24th August). It was noticed that there were a large number of accidents in Nelson in the after school period, and also to pre-school children in termtime. It was hoped that this survey would help to identify why this was so. The survey was carried out in the summer period so that usage of the roads by children would be at something like the annual maximum, and also so that the evenings would be light. The results of this survey would allow some comparisons of exposure and risk to be made between this period, and the school holiday period in Nelson.

After much thought it was decided not to undertake the fourth possibility, a survey in Bristol during termtime, as the small numbers of accidents during this period, particularly to pre-school children, would not have permitted sufficient analyses to justify the effort involved.

It is realised that the number of accidents in each of the chosen periods, even with the 6 years of accident data now available, was not high. Thus the analyses of risk were restricted to general assessments such as the risk to different groups of children, while more specific local breakdowns such as the assessment of risk on particular stretches of road were not possible. It is thought, however, that the detailed results of the exposure survey alone should be of use in assessing where accidents are likely to happen, and to whom, as well as being of more general interest in terms of say the planning and siting of new facilities.

7.2 The information to be collected

It was desired to collect data about a sample of children observed in the streets of each of the selected areas. This information would contain background details about these children (e.g. their age and sex), their location, their accompaniment and their activity. Information about other factors which might have an effect upon these such as traffic flow and the weather would also be collected. It was intended to collect this information over as wide a range of types of environment as the areas chosen contained. It was also considered necessary to collect the information over as wide a variety of periods throughout the day as would be possible. Only one enumerator (the author), and five weekdays were available for each of the three surveys, and therefore in order to be able to collect all this information a new method of data collection had to be devised.

7.3 Methodology of data collection

The method which was used to carry out this survey is different to that for the surveys of journeys to and from school, as described in Chapter 4. Due to the nature of children's play and other non-school-related journeys, it was considered unwise to use a questionnaire, as recall of these more irregular activities and journeys would probably be quite poor. Rather, some form of direct observation was required. There were two basic kinds of observation survey which could be carried out. These have been discussed in Chapter 2, where some of the advantages and disadvantages of each have been identified. The first of these is the moving observer method, whereby the observer(s) moves through an area (in this case on foot, so that the observer moves at roughly the same speed as those being observed) and records the background details, location, and activity of all the children encountered. The second method, and probably the easier to accomplish, would be to undertake observations from particular sites only. In this case because the observer is stationary while making the observations, there is less geographic coverage per enumerator. It was decided finally, that in order to get the most out of the limited number of observers available for these surveys, some elements of both of the methods should be used. To do this the moving observer counts were carried out to a Latin Square pattern (see section 7.3.4), while further stationary counts were also taken at particular locations (Moving OBServer counts will in future be referred to as MOBS, and the Stationary OBServer counts as SOBS). The following sections describe this method in detail.

7.3.1 The routes surveyed. In each study area a route was identified which could be walked around completely in one and a half hours. These routes were split into five sections of equal length. The routes and sections of route were chosen so that, as far as possible, they passed through different types of environment (defined by land-use, road type and accident patterns).

So that each route could be walked in one and a half hours, each section was chosen to be 1100 metres long, experience showing that this took about 18 minutes to walk (though this varied slightly depending on factors such as topography, traffic flow, and the amount of information that the enumerator had to record). The sections followed on so that the starting point of one was the end point of another. When actually carrying out the surveys it was attempted, as far as was possible without affecting the results, to pace each section so that they took as nearly as possible 18 minutes each to walk regardless of topography or interruptions. The time taken to walk each section was noted in the surveys. If a large variation between these occurred, then allowance might have to be made for this when analysing the results. The routes and sections of routes chosen are shown in relation to each other and to the study area as a whole in Figures 7.1 and 7.2. The sections of route are also shown individually in more detail in Figures 7.3 to 7.12. These show the land use types where this is not residential (only shops, areas of open space, and schools are shown), the areas over which the SOBS counts were made, and the location of all the accidents not on a journey to or from school (in the 6 years from 1979-1984). These have been split into 4 categories: on a weekday in termtime; on a weekday in the school holidays; on a weekend in termtime and; on a weekend in the school holidays.

7.3.2 Details of each section. Some of the characteristics of each section will now be discussed for the two areas in turn.

BRISTOL AREA

Section 1 (see Figure 7.3) starts by skirting around the edge of the Southmead Estate along the Pen Park and Southmead roads. These are both main roads. The Southmead Estate was built between 1918 and 1939 and initially contained mostly council-owned houses. This section passes a small neighbourhood shopping centre at the junction of Pen Park and Southmead roads. The final part of Section 1 enters the estate along Shetland Road. This is a minor road. The majority of the accidents here were on and around the main Pen Park and Southmead roads.

Section 2 (see Figure 7.4) goes through the centre of the Southmead estate, and then ends up in a newer, post 1945 housing estate to the north. Again all of this section is through residential areas (in this case mostly on minor roads), except for the point where it passes through the Arneside shopping centre. This (though still only of neighbourhood size) is the biggest area of shops on the whole route in Bristol. The accidents associated with this section were all on minor roads, except for three at the junction of Trowbridge Road and Greystoke Avenue.

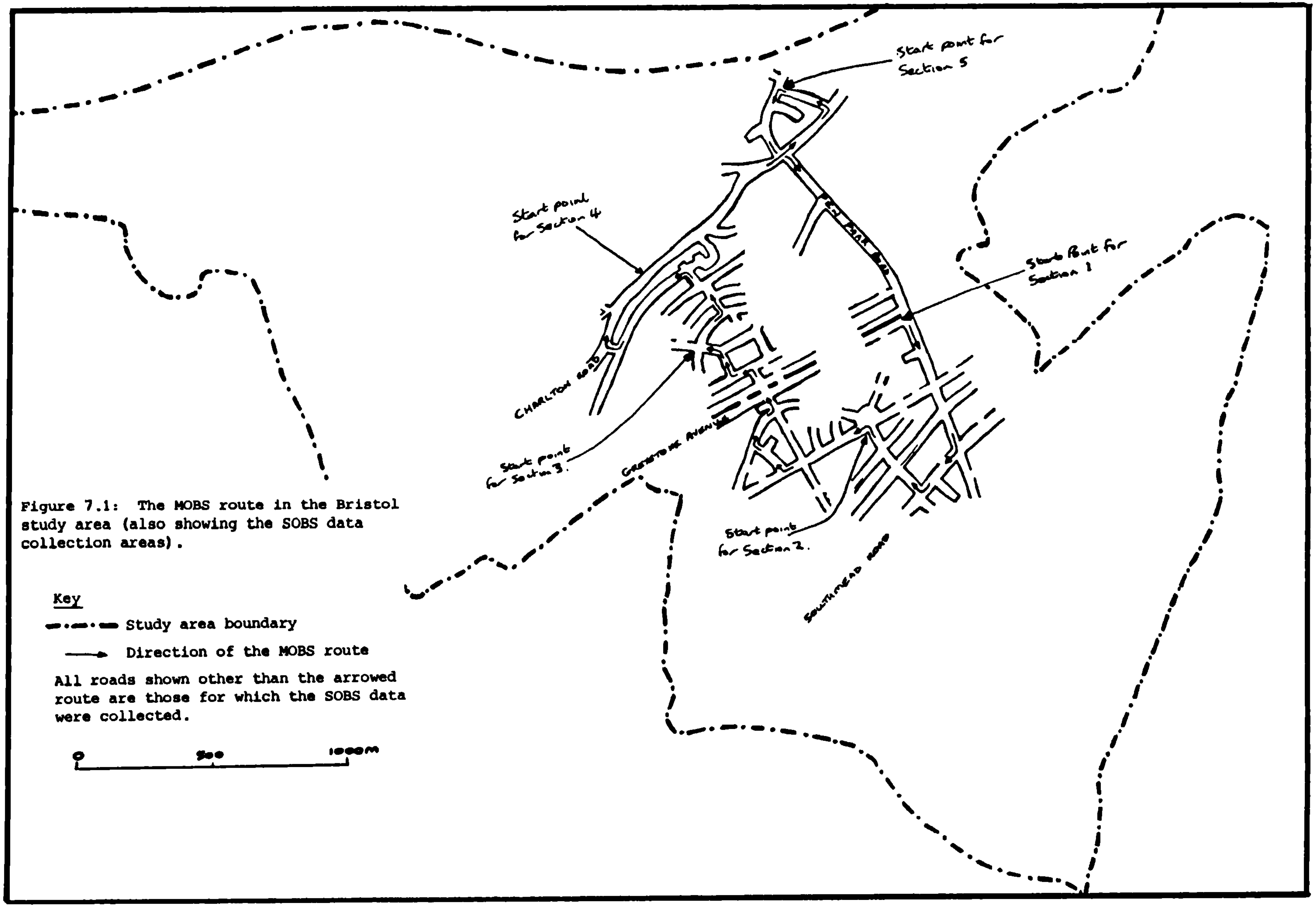


Figure 7.1: The MOBS route in the Bristol study area (also showing the SOBS data collection areas).

Key

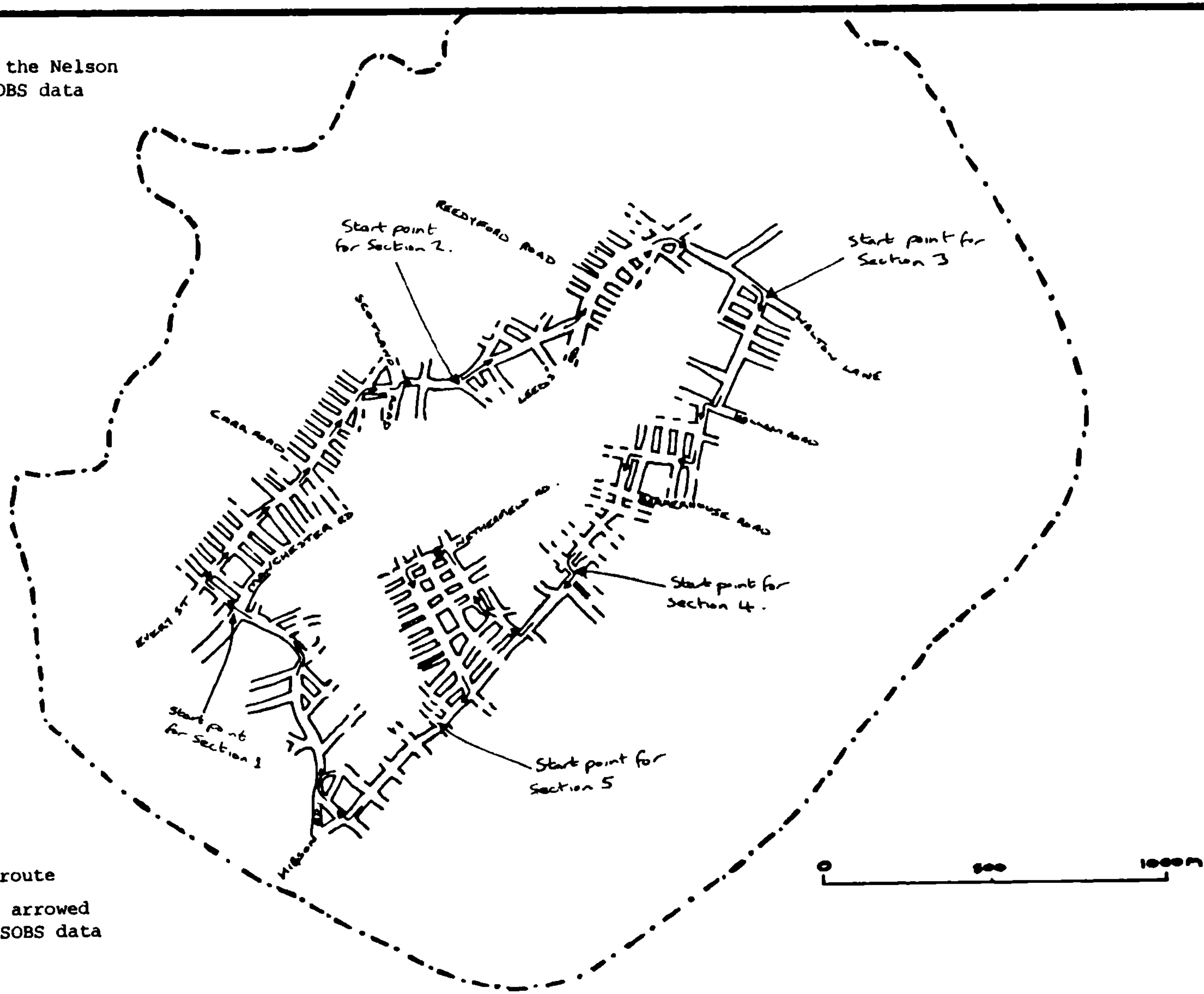
Study area boundary

Direction of the MOBS route

All roads shown other than the arrowed route are those for which the SOBS data were collected.

0 500 1000m

Figure 7.2: The MOBS route in the Nelson study area (also showing the SOBS data collection areas).



Key

Study area boundary

Direction of the MOBS route

All roads shown other than the arrowed route are those for which the SOBS data were collected.

Figure 7.3: Section 1 in the Bristol Study area

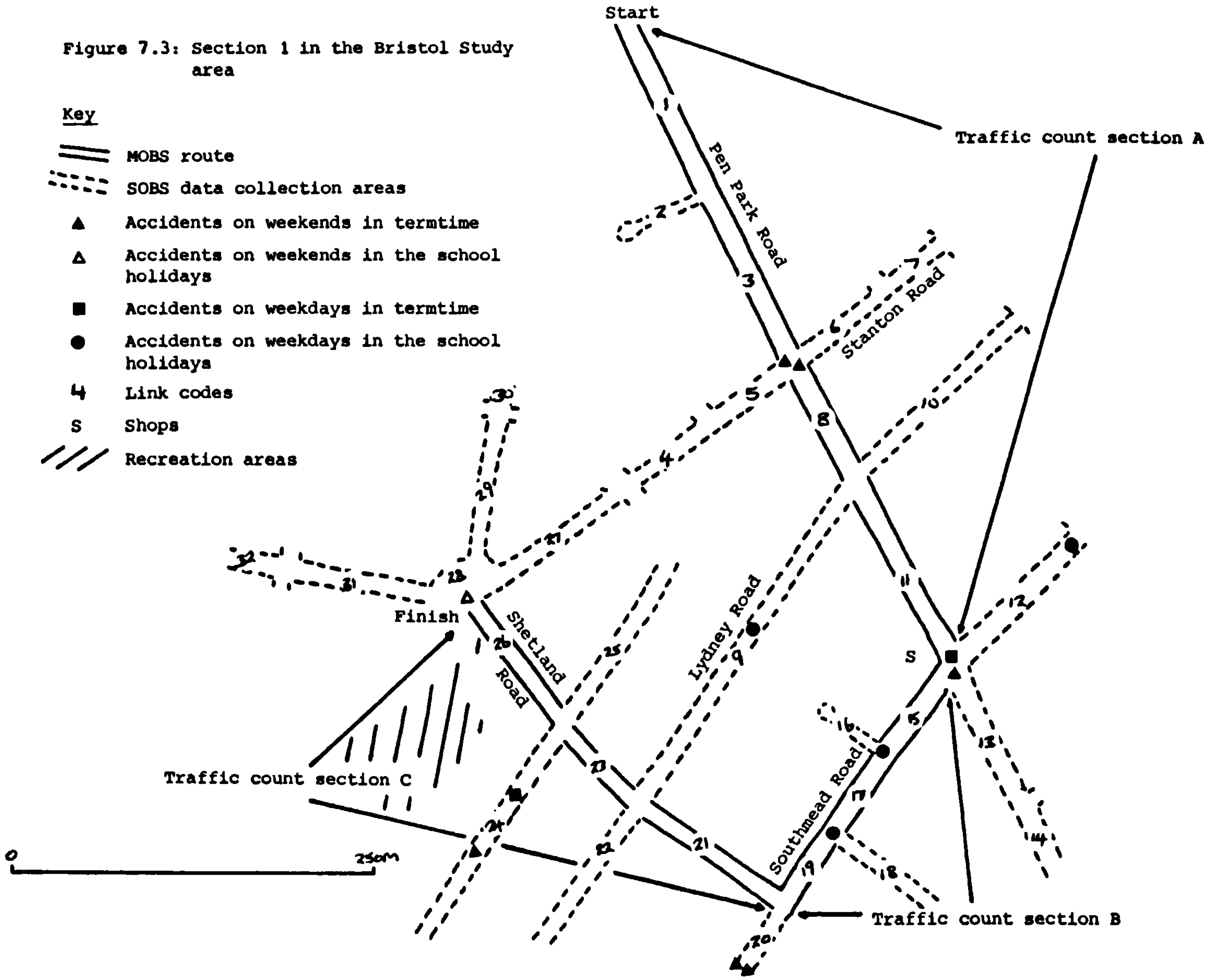


Figure 7.4: Section 2 in the Bristol Study area

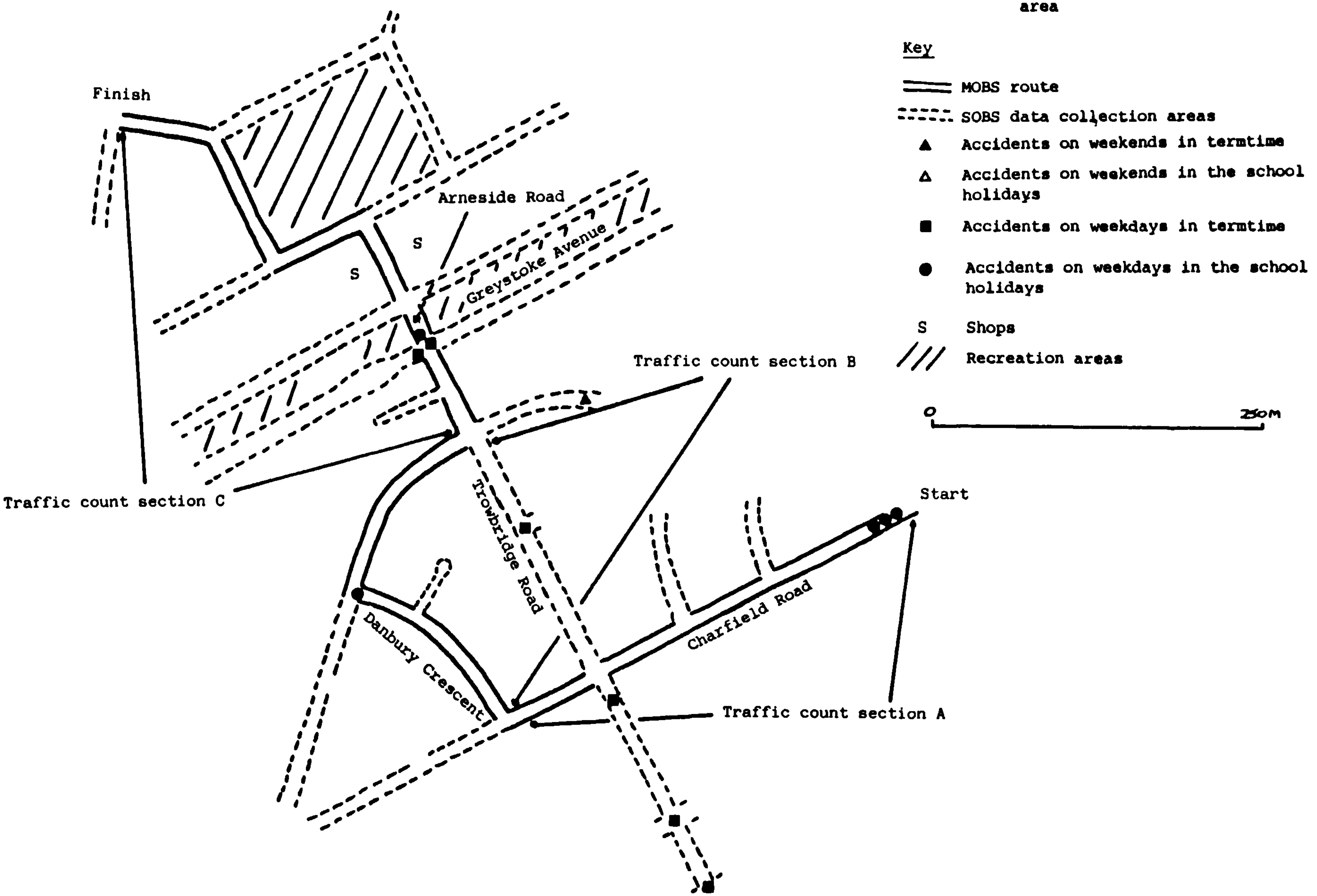


Figure 7.5: Section 3 in the Bristol Study area

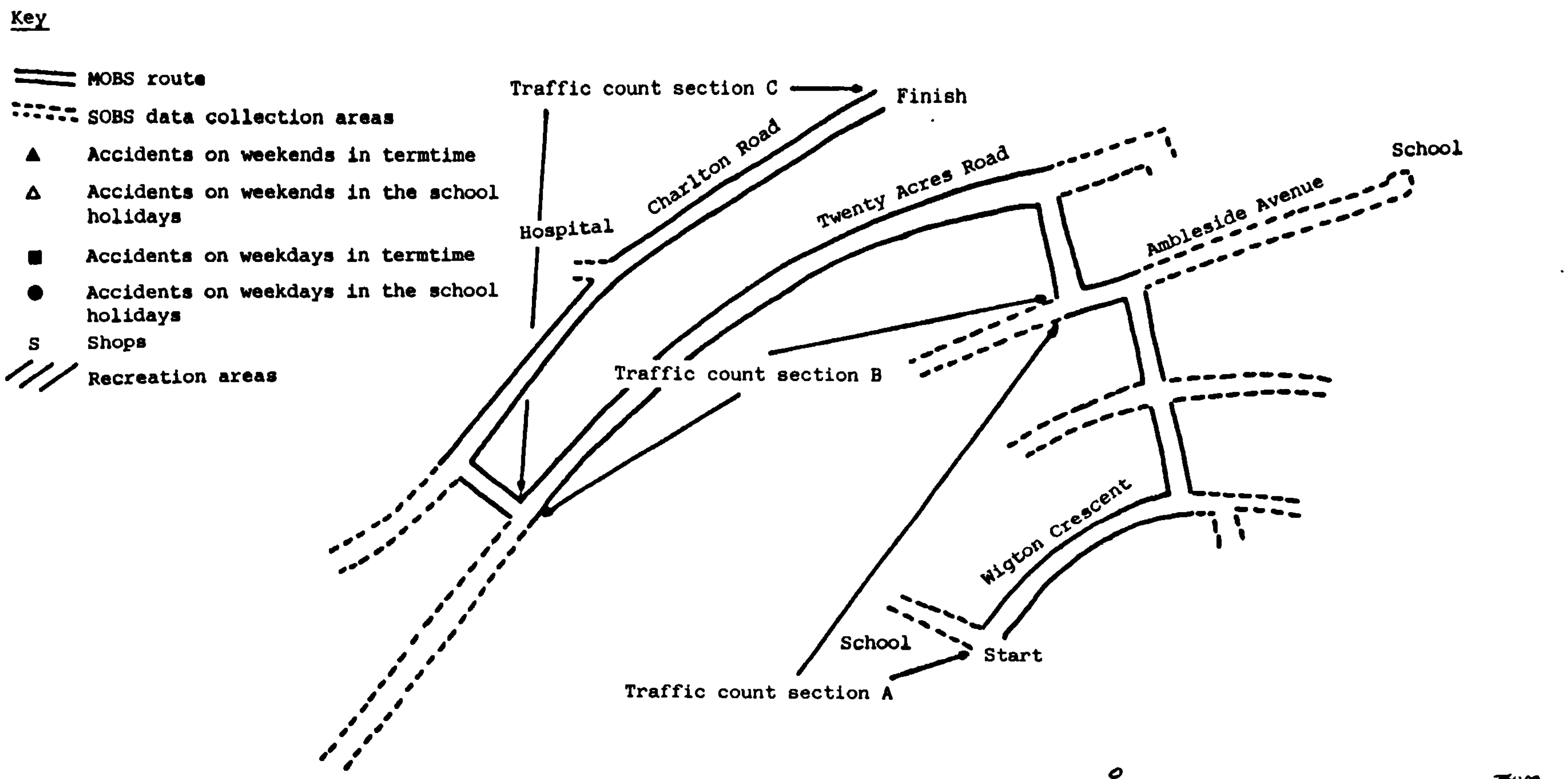
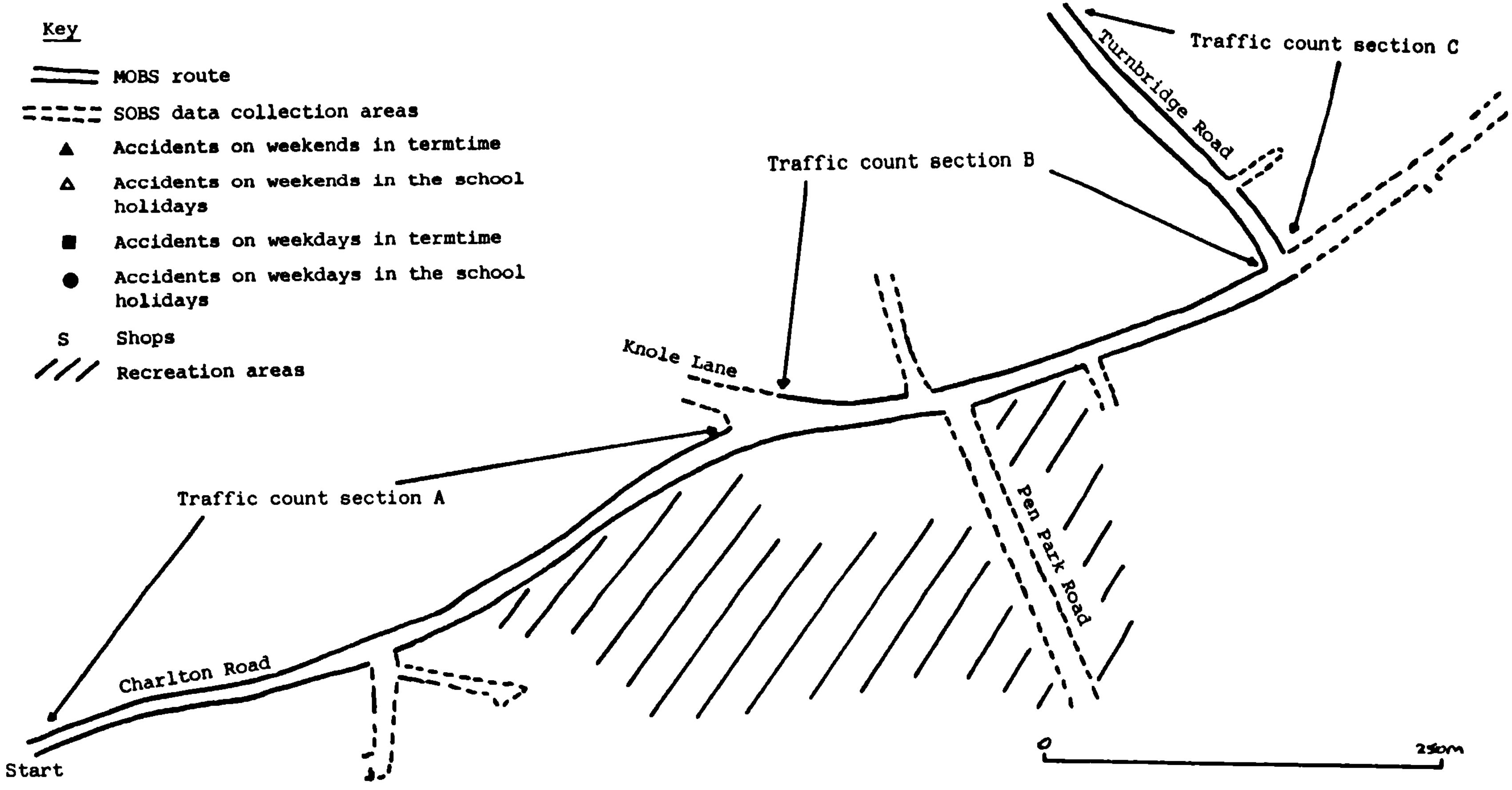


Figure 7.6: Section 4 in the Bristol Study area



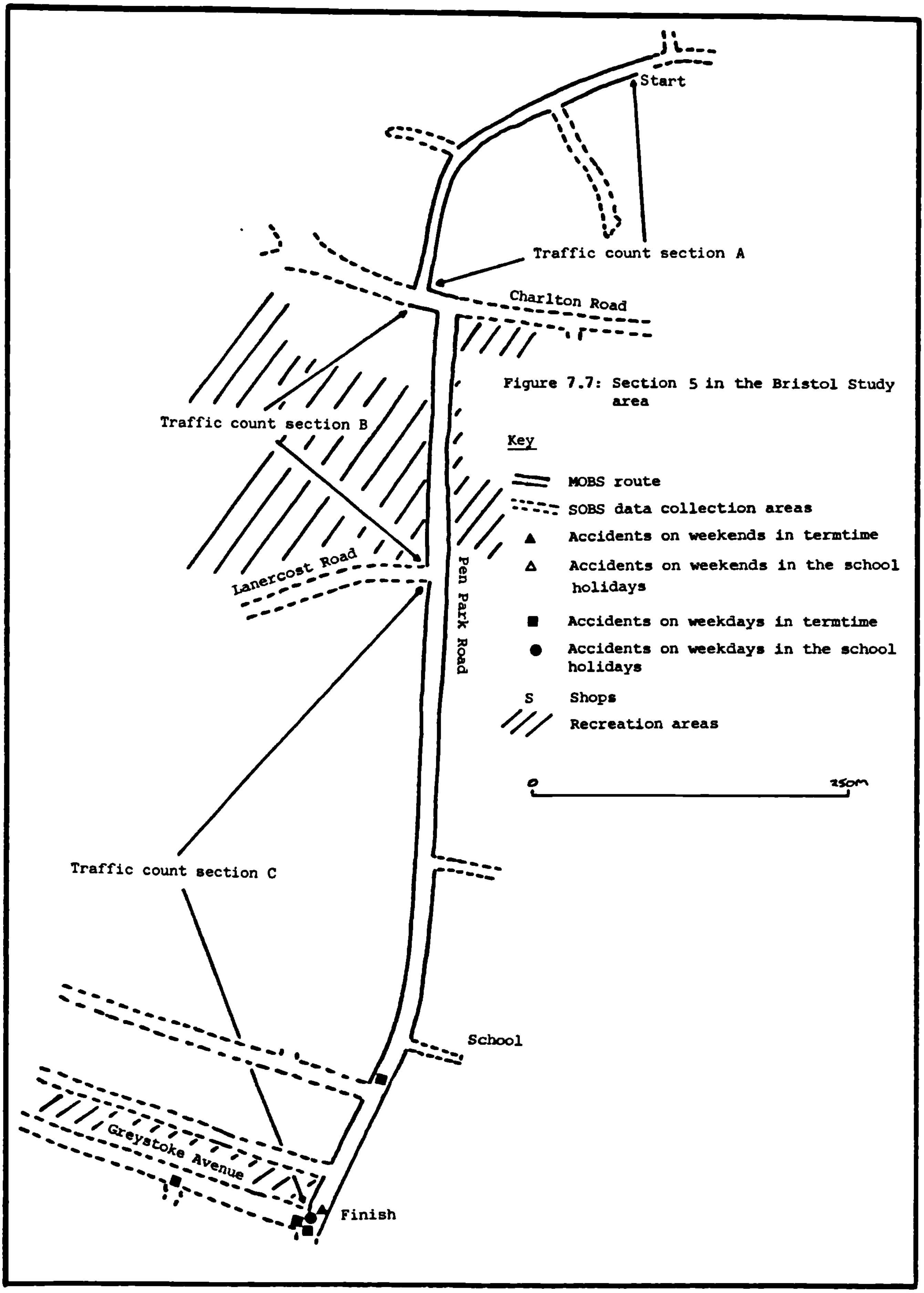
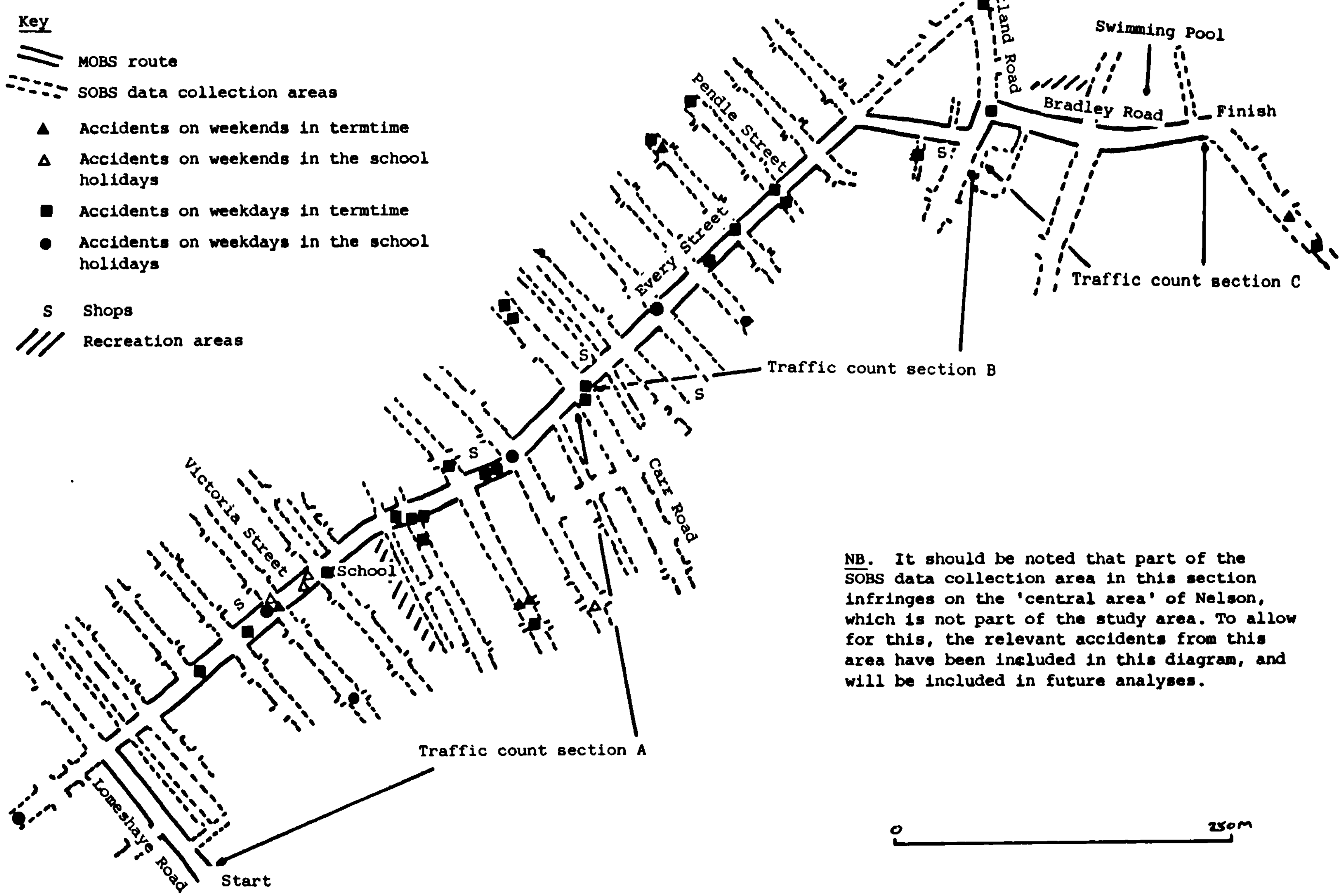


Figure 7.7: Section 5 in the Bristol Study area

Figure 7.8: Section 1 in the Nelson study area



NB. It should be noted that part of the SOBS data collection area in this section infringes on the 'central area' of Nelson, which is not part of the study area. To allow for this, the relevant accidents from this area have been included in this diagram, and will be included in future analyses.

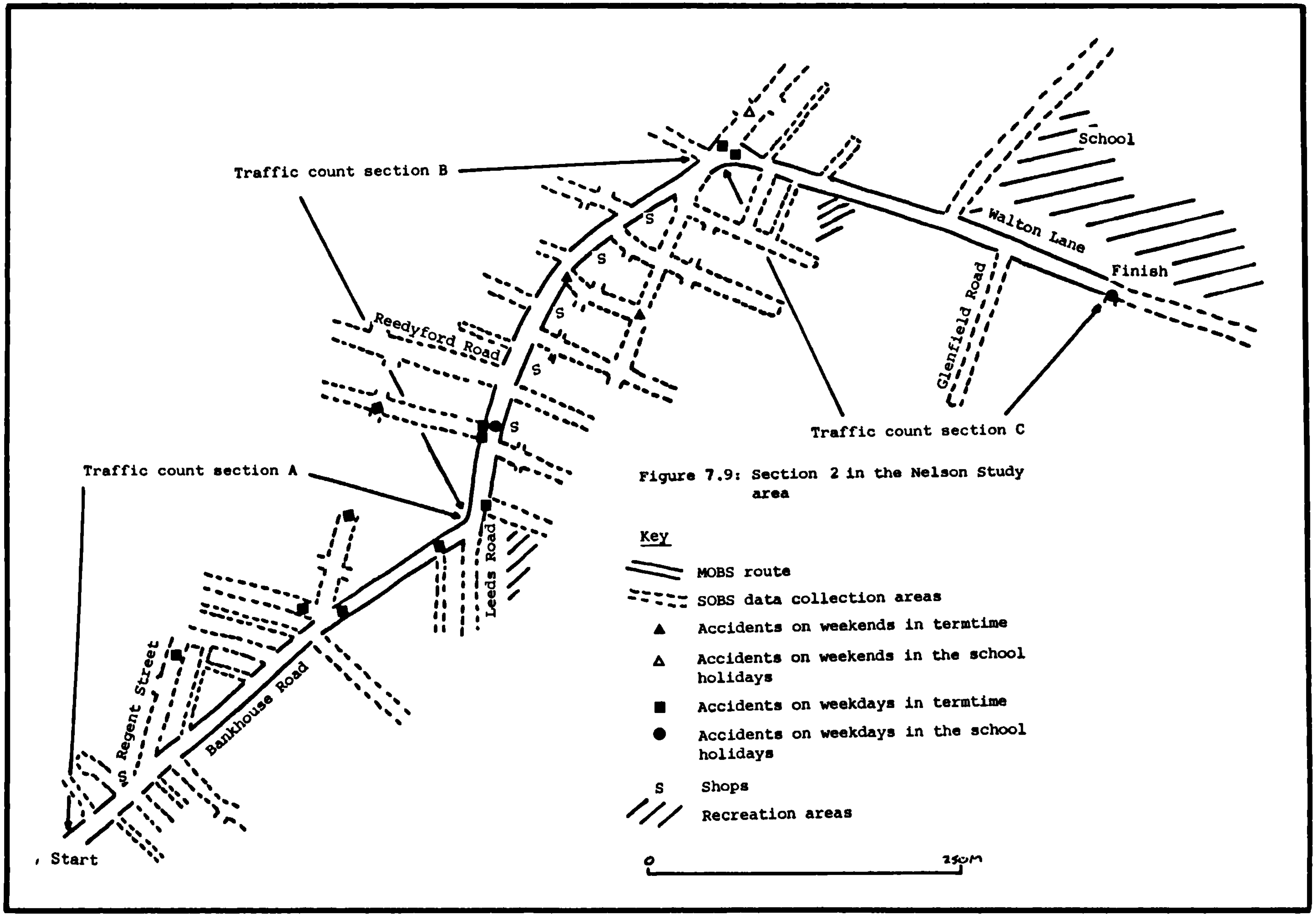
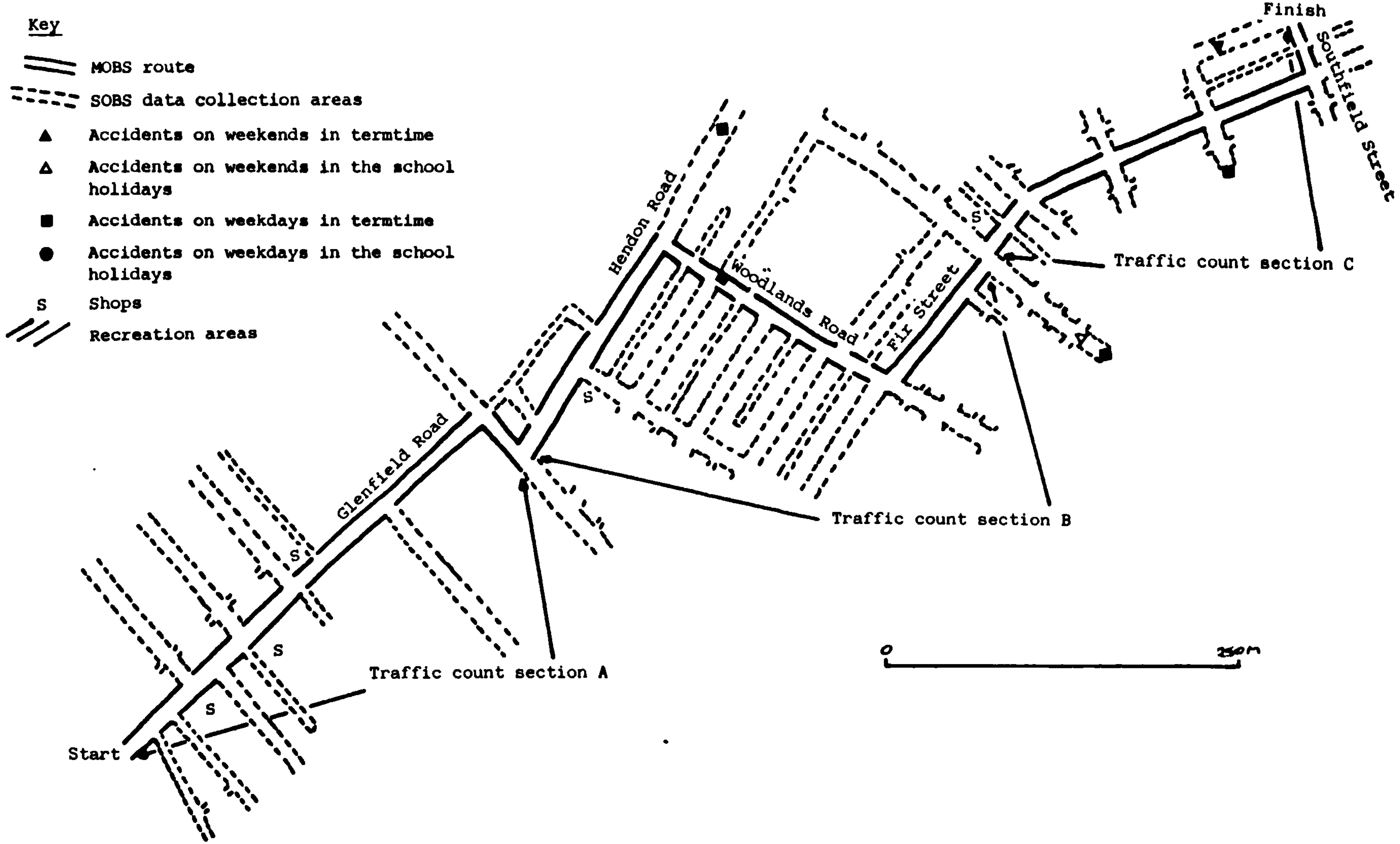


Figure 7.9: Section 2 in the Nelson Study area

Figure 7.10: Section 3 in the Nelson Study area



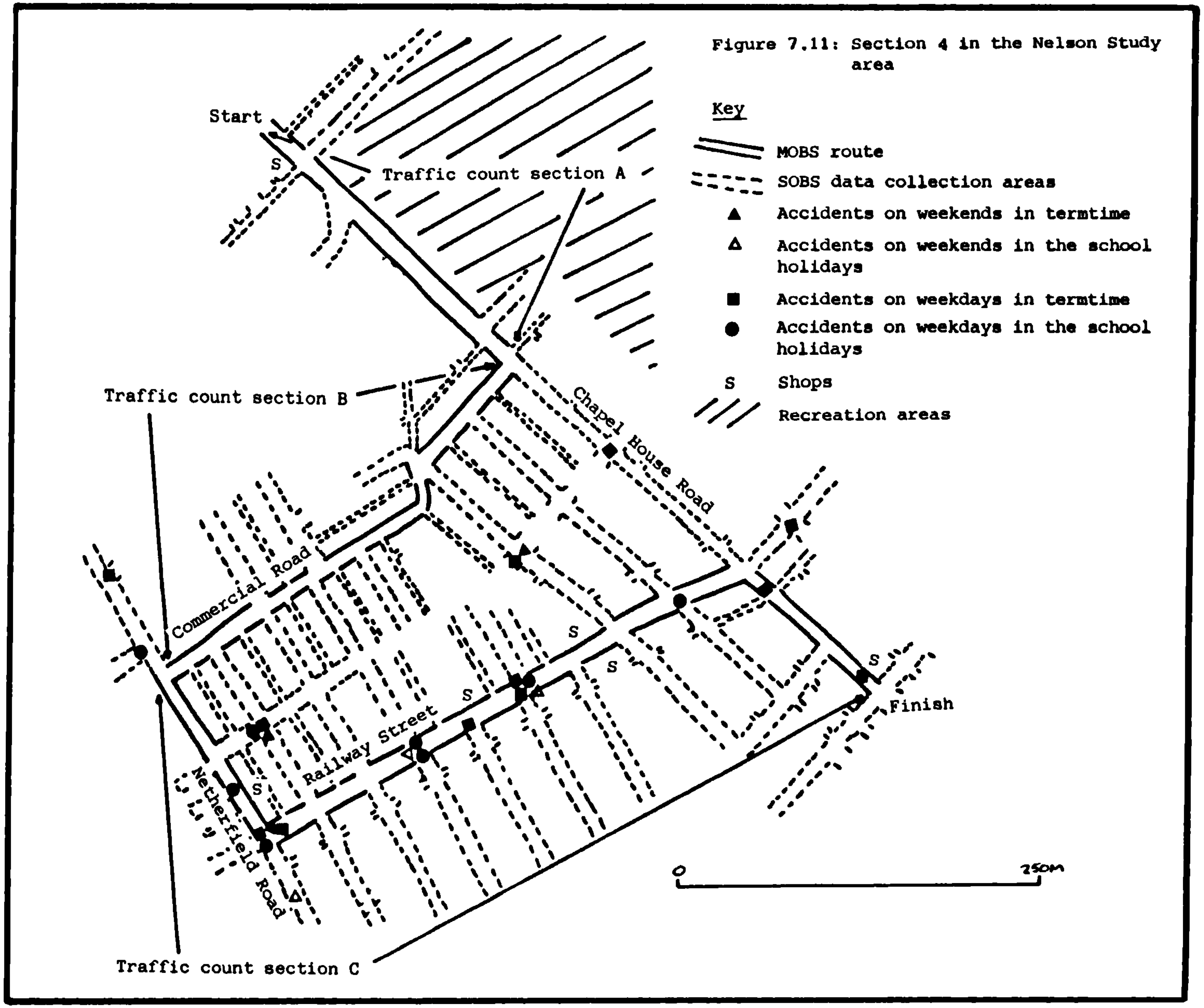
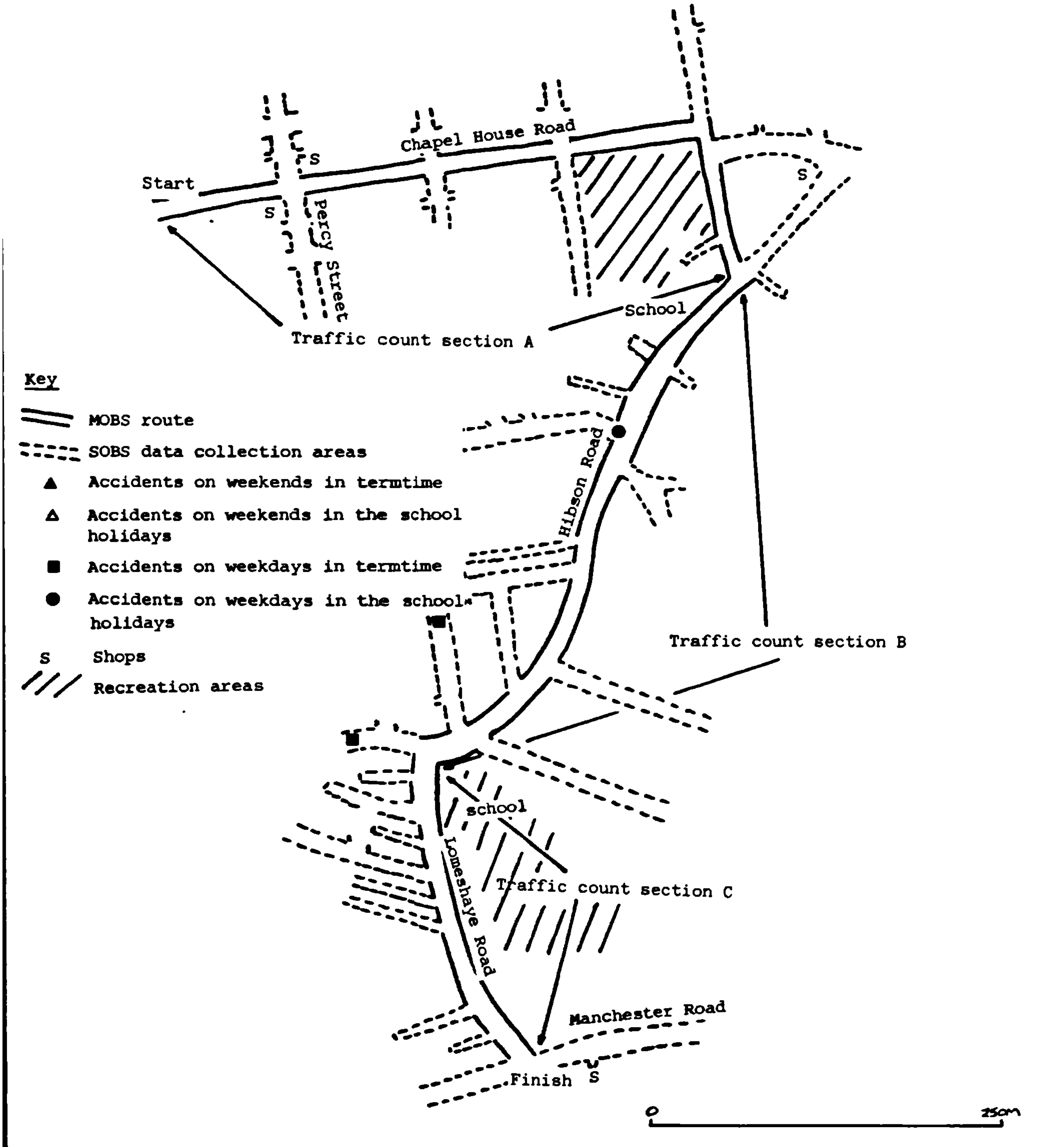


Figure 7.11: Section 4 in the Nelson Study area

Figure 7.12: Section 5 in the Nelson Study area



<u>Section 3</u> (see Figure 7.5) continues through the post 1945 council estate, and then passes by some new private housing on Twenty Acres Road. The roads on this section are largely minor, except perhaps for the final stretch along Charlton Road which, although not carrying a lot of traffic, seems a fairly fast road. This road has housing along one side only, the other being hospital grounds. There were no accidents in this section at all.

<u>Section 4</u> (see Figure 7.6) passes through some open space along Charlton Road, and then enters a small post 1945 council estate at Turnbridge Road. This section goes through the busy junction of Pen Park Road and Charlton Road, with its new mini-roundabout. This section again had no accidents.

<u>Section 5</u> (see Figure 7.7) continues around this small council estate, then once again through the mini-roundabout at the junction of Pen Park Road and Charlton Road, and finally continues down Pen Park Road until it joins up with the start of Section 1. There were no accidents on this section except at the final two junctions. There is open space on both sides of Pen Park Road at the end nearest to the mini-roundabout, while the remainder of this road is surrounded by inter war council housing.

One of the focusses of interest in the exposure study in the Bristol area was the large difference in the accident patterns in the area to the north of Greystoke Avenue which has had few accidents in the 6 year period, and the area to the south which has had more.

NELSON AREA

Section 1 (see Figure 7.8) skirts around the edge of the town centre, through an area of narrow roads and terraced houses. The first part of this section along Every Street had a high accident rate. This road, often used as an alternative to the town's main through route, to which it runs parallel, seemed to carry a lot of traffic. Most of the houses along this road have small front gardens, while the houses on many of the adjacent side roads have no front gardens at all. Dotted around this area are numerous 'corner' shops. Apart from one playground there is very little open space on this section. The final part of this section along Bradley Road passes by some offices and the town's swimming pool.

Section 2 (see Figure 7.9) in its initial stretch along Bankhouse Road is very similar to Section 1, except that there were fewer accidents. There are some shops at the junction with Regent Street. The second part of this section follows along the main Leeds Road. Here there are numerous shops, and a large volume of traffic. The final part of this section is along a quieter road, containing some open space, and along one side, one of the two secondary schools in the town. The houses along this part of the section are bigger, and have more extensive front gardens than those previously encountered.

Section 3 (see Figure 7.10) starts by continuing through an area similar to the last part of Section 2, along minor roads. Towards the end of this section an area of 'back to back' terraced houses is again reached. There were few accidents throughout the whole of this section.

Section 4 (see Figure 7.11) is similar in housing type to Section 1. The first part of this is along a fast, hilly stretch of a narrow road (Chapelhouse Road). The second part goes through an area with very little traffic in which most houses have no front gardens and their front doors open virtually onto the streets. Some blocks of the 'back to back' terraced houses on this part of the section are now being knocked down, and many others are in a poor state of repair. There were few accidents here. The final part of this section passes close to the town centre along Netherfield Road, and then up a steep hill along a fairly busy access road (Railway Street). There are numerous accidents on this stretch. Again some of the houses here have been knocked down, and open 'play' spaces (derelict sites) exist, though in places new houses have been built.

Section 5 (see Figure 7.12) goes through the most prosperous parts of the route, up on a hill, with most houses having front gardens. The final parts of this are along the main Hibson and Lomeshaye Roads. There were very few accidents on this section.

Some of the main focusses of interest in the exposure analyses in Nelson were the differences in accident numbers along the roads in Section 1, and the relatively few accidents in Sections 3 and 5. Also of interest were the exposure and accident patterns on both main and minor roads throughout the survey area.

7.3.3 The times of day surveyed. In both areas each day of survey was split into 5 one and a half hour periods, so that each route could be walked completely 5 times a day by an enumerator (it was decided that having to walk any further would not be realistically possible for just one enumerator). These were chosen to be from 09.00

to 10.30, 10.45 to 12.15, 14.00 to 15.30, 16.45 to 18.15, and 18.30 to 20.00 so that in terms of the survey on school days they did not overlap with the likely times of most journeys to and from school. This would prevent any confusion in terms of journey purpose. These times were also chosen so that they coincided to some extent with the times having the greatest numbers of relevant accidents. It was considered necessary to have all 3 surveys based on the same time periods for ease of analysis and comparison purposes, so the surveys in the school holiday periods were also carried out at these times. It is thought also that these times include some of the highest exposure levels throughout the day, and largely cover the exposure patterns that exist throughout each day, except for the periods of going to and from school.

7.3.4 The Latin Square pattern of data collection. It was intended to obtain measures of the type and amount of usage of the roads on each section of the route for each of the 5 one and half hour periods in each day. In order to achieve this with the single enumerator available, and also the limited amount of time available, it was decided to use a Latin Square method of data collection. This was done in the following manner (see Figure 7.13). On day 1 in the 9.00-10.30 time period Section 1 was patrolled (see figures 7.1 and 7.2), followed by Section 2, and so on up to Section 5. Then in the second period starting at 10.45, Section 2 was surveyed again, followed by Section 3 and so on until Section 1 was surveyed last between 11.57 and 12.15. This pattern was followed throughout the remainder of the day, until in the 18.30-20.00 period the first section patrolled was 5, and the last was Section 4. On day 2 the whole process was repeated except that the first section in the

9.00-10.30 period was section 2, and then the remainder followed on in the same pattern as above. Thus throughout the remainder of this day the sections surveyed were 'one on' from the day before. It can be seen that because there were 5 days, 5 sections, and 5 time periods, then over each survey period of 5 days each of the sections was surveyed for each of the time periods. In terms of manpower and time this represented a particularly effective use of the limited available resources.

In terms of results the use of this survey method meant that it was possible to analyse completely any variable (such as the age or sex of the children) by period of day, by day of week, or by section. The only major restriction on analysis is that it was only possible to examine time within a period (i.e the 18 minute section times) by using the data for all of the days together.

For each survey 125 sections were patrolled in each week by the enumerator, as far as possible at a constant speed. It was found that 15 minute gaps were necessary between the 9.00-10.30 and 10.45-12.15 periods, and the 16.45-18.15 and 18.30-20.00 periods, because the enumerator needed time to get from the end of the last section to the start of the next but one section (which was the next starting point).

Figure 7.13: The Latin Square pattern of data collection

Monday

Time	Section 1	2	3	4	5
9.00-10.30	1	2	3	4	5
10.45-12.15	5	1	2	3	4
14.00-15.30	4	5	1	2	3
16.45-18.15	3	4	5	1	2
18.30-20.00	2	3	4	5	1

Tuesday

Time	Section 1	2	3	4	5
9.00-10.30	5	1	2	3	4
10.45-12.15	4	5	1	2	3
14.00-15.30	3	4	5	1	2
16.45-18.15	2	3	4	5	1
18.30-20.00	1	2	3	4	5

Wednesday

Time	Section 1	2	3	4	5
9.00-10.30	4	5	1	2	3
10.45-12.15	3	4	5	1	2
14.00-15.30	2	3	4	5	1
16.45-18.15	1	2	3	4	5
18.30-20.00	5	1	2	3	4

Thursday

Time	Section 1	2	3	4	5
9.00-10.30	3	4	5	1	2
10.45-12.15	2	3	4	5	1
14.00-15.30	1	2	3	4	5
16.45-18.15	5	1	2	3	4
18.30-20.00	4	5	1	2	3

Friday

Time	Section 1	2	3	4	5
9.00-10.30	2	3	4	5	1
10.45-12.15	1	2	3	4	5
14.00-15.30	5	1	2	3	4
16.45-18.15	4	5	1	2	3
18.30-20.00	3	4	5	1	2

Numbers in the tables refer to the order in which the sections were walked (i.e. 1=1st, 2=2nd, etc.).

7.3.5 Method of recording the data. Data in these surveys was recorded on large scale maps (scale 1:2500) of the areas (see Figure 7.14 for an example) which were carried around by the enumerator. A separate map was available for each section of route each time it was surveyed. The location of each child observed was marked on the maps at the point at which they were passed, or passed the enumerator, using adhesive dots. On these dots the details of the children seen were recorded using a predefined code (see Figure 7.14 for details of this code). By noting locations on the map in this way it would be possible to identify unusually large groups of children such as those at a bus stop or on a group outing, and also to retain a record of the location of each child. If a child was passed more than once then they were entered into the survey more than once, though in practice this rarely happened. Children who were seen in the distance on the MOBS routes, but were no longer there when that point was reached, or who followed behind the enumerator (either because they were travelling in the same direction, or because they were curious about what the enumerator was doing) were not included in the survey.

It was thought that all children in the road environment, not just those actually in the road itself (a number which due to the nature of the survey would probably not be high) should be considered to be at risk and therefore included in the data collection and analyses. This is thought to be consistent with the manner in which children play, and the possibility of them dashing into the road. Thus details of children seen on the pavement and in the immediate road environs (e.g. in gardens beside the pavement), as well as those actually in the road itself, were recorded on the large scale maps, though each was categorised differently for the purposes of analyses.

As well as recording information about children seen on the MOBS routes, it was also thought worthwhile to do a series of what are essentially stationary counts while the MOBS survey was in progress. This would increase the area over which the survey could be carried out. These counts were made at each junction of the routes with another road. At these points the enumerator looked down the arms of the junction (to a predetermined distance) and noted on the map the same information as for the MOBS surveys for all the children using those stretches of road. The extent of the areas used for the collection of this data is shown in Figures 7.3 to 7.12.

The enumerator also recorded the time taken to walk each section, and the amount of traffic encountered on each section of the MOBS routes.

7.4 Pilot studies

Each of the two areas was visited for a day before the main surveys were carried out so that the routes could be tested and small problems ironed out. During these pilot studies the actual techniques used for the collection of the data were perfected. Results of these surveys showed that it was possible to collect the data adequately using the above method, although the recording of the data became complex if a lot of children (more than say 20) were encountered in one location, especially if they were considered to be independent of each other, and not in groups, as these took longer to note down. Difficulties were also encountered on main roads where a lot of traffic was passing. It is recommended that any crossing of main roads by the enumerator should be done at crossing facilities, so that their fullest attention can be given to the tasks in hand.

Some problems were obviously encountered when ascertaining the age, and even the sex of the children observed. It was partly for this reason that only 3 age groupings were used in the surveys, to try to minimise the likelihood of some children being wrongly categorised. It is likely that despite this, a proportion of the children would have been wrongly categorised in terms of age, and a smaller proportion in terms of sex. This would (short of asking the children) appear to be an unavoidable problem, though how much it can be minimised by practising age estimation on children of known age is not known.

The ability of the enumerator to collect traffic flow information at the same time as surveying children's exposure was also tested. This data was collected by counting the total number of vehicles which passed the enumerator in both directions while patrolling each section of route. The results of the pilot surveys showed that it was better in terms of traffic data collection to split the sections of route up. This was because the sections were not nearly consistent throughout their length in terms of the amount of traffic flowing along them, and so the traffic flow information from the sections as a whole would not be very meaningful. For this purpose, each section was split up into 3 parts, each as far as possible having a particular type of traffic flow (see Figures 7.3 to 7.12 for the extent of these sections). Each section was split into three parts because it was thought that this was enough to avoid a big difference in traffic conditions within a given part, without either making the recording task too complicated or producing parts so short that reasonable estimates of flow could not be made in the time spent traversing them. Also, all of the sections (in both of the areas) seemed to split readily into three different parts, each of which was fairly consistent in the pattern of traffic flow throughout its length.

The pilot studies were used to test the suitability of the sections of route for this sort of data collection. In at least one case a section that was tried out was changed slightly as a result of the pilot studies. This was because part of it went through an industrial area in Nelson, which turned out to have no children using the roads at all, and thus was worthless in terms of the aims of this survey. Other very minor changes were made to the routes. Also assessed were which side of the road the enumerator should walk on, and where roads should be crossed to reduce the likelihood of delay.

The pilot studies were also used to test other minor aspects of the surveys, such as how many children were likely to be seen (if the number was too few then it was probably not worthwhile continuing with the surveys in those areas). Also tested was whether it was possible to get from the end point of a section to the start point of the next but one section in the 15 minutes that was available between 10.30 and 10.45, and between 18.15 and 18.30. This was in fact done by using a car. Finally these studies were used to identify the extent of the SOBS data recording areas (i.e. how far it was possible to see down a side road, and still be able to identify adequately the age and sex of a child seen there).

The results of the pilot studies were very encouraging in terms of all of the above, and so it was decided to go ahead with the main surveys in this form.

7.5 Coding of the results

The characteristics of each child observed in the surveys were coded up and entered into the computer for analysis. This, like the coding of the results of the surveys of journeys to and from school was a very extensive task.

The meaning and derivation of most of the variables coded is fairly obvious, but some further discussion is useful. Appendix C.1 gives a list of all the variables recorded and the possible values that could be given to each. It can be seen from this that the variables fall into one of several classes. Firstly there are a group concerned with the location of each observed child in time and space. The variable 'Link' in this group needs some further explanation. These links are defined in the same way as for the survey of children's journeys to and from school (see section 5.7.1). As shown above, the position of each child was recorded during the 'play' surveys on large scale maps. This position could then be identified with the relevant link code, and this could be recorded onto the computer as the variable 'link'. By way of example, Figure 7.3 shows the locations of some link codes for one of the sections in the Bristol study area. It was envisaged that by combining relevant links, types of road (e.g main or minor) or environment (e.g areas of shops) could be identified and the number of children using these types of areas defined.

Further sets of variables concern the background of the child (their age and sex), and the child's accompaniment. These accompaniment variables list the number of adults, older children, and contemporaries and younger children who were with the child at the time of observation. If a mixture of these people were present, then they were recorded as such. It is important to note that the variable 'olderacc' records children who are an age group at least (as defined by the variable 'age') older than the observed child. That is for pre-school children 'olderacc' could either refer to accompaniment by primary school children or secondary school children. For primary school children it could only refer to accompaniment by secondary school children. For secondary school children 'olderacc' always equals zero (as older age groups of children do not exist).

The categories for the activity of the child were worked out from the pilot studies, on the basis of the most common activities that were seen on those surveys. All possible combinations of these activities were recorded as such. Thus if a child was observed playing and cycling at the same time they were recorded as doing both.

One difference exists in the activity categories between the two areas. In Bristol it was noticed during the pilot study that there were a large number of children using 'BMX' type bicycles. For this reason a separate category from normal bicycle use was made. In Nelson, as very few of these 'BMX' bicycles were seen on the surveys, this was not considered necessary, and so this activity was not recorded.

The definition of an activity was sometimes a little difficult to make. If for instance a child was playing then they were categorised as such. However, if the child was simply walking along the street, while it is quite possible that they were playing, they were not categorised as such, but rather as 'walking'. If it was thought that there was some likelihood that the child might be playing, but the enumerator was still unsure, then they were categorised as 'walking playing'. Children were only categorised as being on an errand if the enumerator felt quite certain that they were (for instance if they were on a milk or paper round). Thus it is likely that a lot of children classified as 'walking' or 'running' were in fact on errands, or indeed playing. Short of asking the child, it was not considered possible to be any more accurate in the definitions of activities than this.

For the purposes of recording the data the results were split into two groups. This was done on the basis of whether the observed child was seen on one of the moving observer routes (MOBS), or was seen in one of the stationary observation areas (SOBS). The variable 'mobssobs' contains this distinction. The important difference between data collected in these two different areas is that MOBS data can be referred to the traffic flow data and used in analyses involving this. However the SOBS data, for which there is no corresponding traffic data, cannot.

7.6 Storage and access to the data sets

The data have been stored at the University of London Computer Centre (ULCC) using a computer package called SAS (SAS,1982). For a discussion of the attributes of this package see section 5.8. The data are stored in three separate data sets relating to the surveys. These are called .Nplay1 (the Nelson holiday survey), .Bplay1 (the Bristol survey), and .Nplay2 (the Nelson termtime survey).

CHAPTER 8

RESULTS OF THE SURVEY OF CHILDREN'S USE OF THE ROADS FOR REASONS OTHER THAN GOING TO AND FROM SCHOOL

The first part of this chapter will examine some of the results which have been obtained from the three surveys of children's use of the roads for reasons other than going to and from school. Initially, the results of these surveys will be considered separately and then, where relevant, comparisons between the three will be made. Only those analyses of the data that are most relevant in the context of the thesis as a whole are considered here. Chapter 10 describes some other possible future analyses along with other such analyses related to previous chapters in the thesis.

The second part of this chapter will examine the relative risk of some of the groups of children observed on the streets of the survey areas, in different types of location and periods of the day. These analyses make use of data both from the first part of this chapter, and from the accident analyses carried out in Chapters 3 and 7.

8.1 The exposure measures obtained from the surveys

Unlike the surveys of children's journeys to and from school, in which several measures of exposure were obtained (the time spent in the road environment, the number of roads crossed, and the distance travelled), only one such measure was obtained in the surveys of children's play. This was the number of children (of a certain age and sex) observed on the streets of the two areas at particular times and locations.

8.2 The effect of external factors upon the number of children observed

It is intended, before examining the exposure results obtained from the surveys, to discuss briefly two parameters which might have had an effect upon the number of children observed using the streets. These are the weather conditions throughout each of the surveys, and the time it took the enumerator to walk each section.

8.2.1 Weather conditions. As shown in Appendix C.1, three types of weather conditions were recorded. These were 'dry and sunny', 'overcast', and 'raining'. Tables 8.1-8.3 show the weather conditions during each period of the day for each day of the week, for the Nelson schoolday, the Nelson school holiday and the Bristol school holiday surveys respectively.

Table 8.1: Number of children observed in the Nelson schoolday survey by day of week, time of day and weather conditions.

Day and Period		Weather*	Number of children	Day and Period		Weather*	Number of children
Mon	1	DS	55	Thu	1	O	34
	2	DS	51		2	O	36
	3	DS	51		3	DS	51
	4	DS	211		4	DS	234
	5	DS	286		5	DS	320
All periods			654	All periods			675
Tue	1	O	59	Fri	1	O	22
	2	1-4O, 5DS**	61		2	O	29
	3	DS	45		3	O	34
	4	DS	215		4	O	162
	5	DS	318		5	O	277
All periods			698	All periods			524
Wed	1	O	39				
	2	1-4O,5DS	43				
	3	DS	52				
	4	DS	216				
	5	DS	284				
All periods			634				

* DS = Dry and sunny, O = Overcast, R = Raining

** Numbers before one of the above letters refer to the sections on which the weather was experienced (i.e 1-2 means the first two sections walked on a particular day and period).

Table 8.2: Number of children observed in the Nelson school holiday survey by day of week, time of day and weather conditions.

Day and Period		Weather*	Number of children	Day and Period		Weather*	Number of children
Mon	1	O	73	Thu	1	R	23
	2	O	198		2	1R,2-5O	127
	3	DS	315		3	O	259
	4	DS	195		4	1-2O, 3-4DS,5O	239
	5	DS	292		5	R	80
All periods			1073	All periods			728
Tue	1	O	52	Fri	1	O	64
	2	1-3O, 4-5DS**	193		2	O	189
	3	DS	302		3	1-2O,3-5R	153
	4	DS	194		4	O	186
	5	DS	288		5	1O,2-5R	104
All periods			1029	All periods			696
Wed	1	O	111				
	2	DS	195				
	3	DS	245				
	4	DS	176				
	5	DS	287				
All periods			1014				

* DS = Dry and sunny, O = Overcast, R = Raining

** Numbers before one of the above letters refer to the sections on which the weather was experienced (i.e 1-2 means the first two sections walked on a particular day and period).

Table 8.3: Number of children observed in the Bristol school holiday survey by day of week, time of day and weather conditions.

Day and Period		Weather*	Number of children	Day and Period		Weather*	Number of children
Mon	1	0	75	Thu	1	0	65
	2	0	123		2	0	119
	3	10, 2-5DS**	140		3	0	134
	4	DS	114		4	DS	127
	5	DS	130		5	DS	142
All periods			582	All periods			587
Tue	1	10,2-5DS	75	Fri	1	0	57
	2	DS	153		2	0	122
	3	1DS,2-50	175		3	10,2-5DS	136
	4	DS	110		4	DS	98
	5	1-4DS,50	125		5	DS	124
All periods			638	All periods			537
Wed	1	DS	66				
	2	DS	151				
	3	DS	109				
	4	DS	94				
	5	DS	126				
All periods			546				

* DS = Dry and sunny, 0 = Overcast, R = Raining

** Numbers before one of the above letters refer to the sections on which the weather was experienced (i.e 1-2 means the first two sections walked on a particular day and period).

It can be seen from these tables that it only actually rained during one of the surveys, the Nelson school holiday survey, and then only on two of the five days. Table 8.2 shows that in the Nelson school holiday survey during the periods when it was raining there were in most cases substantially less children observed than during the corresponding periods of other days when it was not raining. This could possibly be due to variations in the number of children using the streets between days and periods, but this is thought to be unlikely, as the same degree of variation is not apparent in either of the other two surveys shown in Tables 8.1 and 8.3.

It was also thought that overcast conditions might put some children off using the streets, particularly for play purposes, compared to dry and sunny conditions. Such differences are much less obvious in the tables, possibly because of the different types of overcast weather which can occur, such as when it is overcast and looks like rain, or when it is overcast but obviously about to brighten up. Table 8.1 shows that on Friday, during the last three periods of the day when the skies were overcast, there were less children observed than in the corresponding three periods on Monday to Thursday when the weather was dry and sunny.

The weather may also have had an effect upon the distribution of some of the variables analysed in later sections of this chapter. This is particularly likely to be the case in the Nelson school holiday survey, when it rained for part of the last two days. It is thought that the distribution of three of the variables in particular may vary between times when the weather is wet, and times when it is dry. These are the sex of the children observed (the proportion of boys on the streets might be higher when it is raining), the age of the children observed (the proportion of older children on the streets might be higher when it is raining), and the activities of the children observed (the proportion of children playing might be lower when it is raining). No other variables (see Appendix C.1 for a list) were thought likely to vary between wet and dry periods, except perhaps those related to accompaniment. However, it was considered that a test of the relationship between accompaniment and weather would not be very easy to do because of the nature of the variables and the fact that some children were often accompanied by more than one type of person.

In order to test if any differences existed between the proportions of children observed who were of each age or sex, or were involved in certain types of activity, between wet and dry conditions, data from Period 5 in the Nelson school holiday survey on Monday to Wednesday (dry conditions) were compared to corresponding data for Thursday and Friday (wet conditions). Table 8.4 shows these breakdowns.

Table 8.4: The number of children observed in the Nelson school holiday survey during Period 5 on certain days of the week, by sex, age and activity (all figures except the base are percentages).

	Mon - Wed*	Thu - Fri**	All days
Sex:			
Boys	66.2	72.8	67.4
Girls	33.8	27.2	32.6
Age:			
Pre-school	21.1	14.1	19.9
Primary	57.3	52.7	56.5
Secondary	21.6	33.2	23.6
Activity:			
Walk/errand	15.7	29.3	18.1
Playing (both on foot and bicycles)	70.1	61.4	68.6
Cycling	3.2	2.2	3.0
Other	11.0	7.1	10.3
Base	867	184	1051

* Dry periods
** Wet periods

This shows firstly that the ratio of boys to girls observed in wet periods was about 2.7, whereas in dry conditions it was only about 2.0. This difference is not very likely to have arisen by chance (x^2 with 1 degree of freedom = 3.0, p>0.08). Assuming that such a difference could be shown to be real, it could arise for a number of reasons: that girls like using the roads in the rain less than boys; that the type of uses boys make of the roads are less affected by rain than the type of uses that girls make of the roads; or that parents are more protective towards girls than boys and do not let them out as often when it is raining.

Table 8.4 also shows that the proportions of pre-school and to a lesser extent primary school children observed during dry periods were higher than the proportions observed during wet periods, while the opposite was the case for secondary school children. These differences are very unlikely to have arisen by chance (χ^2 with 2 degrees of freedom = 13.7, p<0.001). They most likely arise because parents are less happy about or have more control over very young children being outside when it is raining, than they have over older children. It might also be partly because older children tend to use roads further from home more than the youngest children, who often play just outside their homes. In the event of rain it would then be easier for the youngest children to retreat indoors quickly than secondary school children who would take a longer time to return home.

Finally, Table 8.4 shows that the proportion of children observed walking/on errands is higher during wet periods than dry periods, while the opposite is the case for all other types of activity. These differences are very unlikely to have arisen by chance (χ^2 with 3 degrees of freedom = 21.0, p<0.001). They probably occur because certain errand type journeys, such as going to the shops, may either be urgent, relatively short, or enforced upon the child, and thus be more likely to take place regardless of the weather. Other activities such as play can always be continued when the weather improves (and are often very unpleasant when it is wet), and so are less likely to take place in wet periods.

8.2.2 Enumerator walk times. The enumerator found it impossible to pace each of the sections so that they took exactly 18 minutes to walk. Because of this there was some degree of variation in the time taken to walk each section, and thus probably also some differences between the actual numbers of children observed, and the numbers which should ideally have been observed had all the sections taken 18 minutes to walk. In very few cases did the enumerator exceed the time allowed to walk a section. In most cases the time was either just under or around the 18 minute mark, though in a few instances it went lower (down to 12 minutes). The main reason for lower walk times on some of the sections, was the small number of children observed on those sections (although other factors such as the amount of traffic and the tiredness of the enumerator also had an effect). The act of recording a child's details (see Chapter 7) took a period of time, and so generally where there were a lot of children, the time taken to walk a section was longer (During the pilot studies when the time it should take to walk a section was decided upon, there were a lot of children observed). Thus, the greatest difference between the number of children observed, and the number which should have been observed had the 18 minutes walk time been adhered to, will have been for those sections where very few children were observed. Because of this, it is thought that the absolute difference in the numbers of children actually observed, and those who should have been observed will be small. It is also thought unlikely that the variation in times will affect the proportions of the various age, sex and activity groups observed.

8.3 The age and sex of the children observed

This will be considered for each of the three surveys in turn and, where relevant, comparisons will be made between the surveys. The age and sex of the children observed will be examined for each survey as a whole, for different locations on each of the routes, and at different times of the day.

Population figures used in the following sections were obtained from the 1981 Census of Population. The figures given are for the study areas as a whole, rather than just for the part of the study area surveyed. It would have been possible to obtain population data for this latter area, though for a number of reasons this was not done. Firstly, the areas surveyed include a large proportion of the total number of ED's in the two study areas, and thus the population characteristics of the study areas can be expected to be similar to those of the areas surveyed. Secondly, each of the MOBs routes was designed to pass through as varied an environment as possible within each study area, and so the surveyed areas are not deliberately unrepresentative of the study areas. Finally, it is desirable when comparing the population characteristics of children in an area with the characteristics of an observed population of children within that area, to keep to a minimum the number of observed children who originate from outside that area. If population figures were obtained only for the surveyed areas, then the number of children observed who originated from outside that area is likely to be higher than if the population data was obtained for the study areas as a whole. This is because the study areas were originally chosen to have definite boundaries (see Section 3.1), which meant that there was limited interaction with areas immediately outside.

8.3.1 <u>The Nelson schoolday survey</u>. During the 5 weekdays over which this survey was undertaken, a total of 3185 children were observed on the streets. Of these, 1503 (47.2%) were observed on the MOBs route. The other 1682 (52.8%) were observed in the SOBs data collection areas. Table 8.5 shows the number of children of each age and sex observed and the number of children of each age and sex living in the study areas.

Table 8.5: Age and sex of the children observed in the Nelson schoolday survey (obs.), and the number of children of each age and sex living in the study area as a whole (pop.).

Age	Sex				Total	
	Boys		Girls			
	Obs.	Pop.	Obs.	Pop.	Obs.	Pop.
Pre-school	574	1192	549	1083	1123	2275
Primary	753	1335	465	1189	1218	2524
Secondary	614	1124	230	1029	844	2153
Total	1941	3651	1244	3301	3185	6952

This shows that about three-fifths of the children observed were boys, and that this proportion varies with age, with approximately equal proportions of boys and girls of pre-school age observed (51.1% boys), while for the older age groups there were larger proportions of boys than girls (61.8% of primary school age children and 72.7% of secondary school age children observed were boys). Using the census figures for the Nelson study area as a whole, shown in Table 8.5, it can be seen that a greater proportion of the observed population were boys, than the proportion of the study area population. Thus boys were relatively overrepresented on the streets, while girls were underrepresented. For pre-school age children, boys and girls were observed on the streets in roughly the same proportions as they occur in the population. However, for both of the older age groups, particularly secondary school children, boys were overrepresented compared to girls.

In terms of age alone, 38.2% of the children observed were of primary school age, 35.3% were of pre-school age and 26.5% were of secondary school age. Thus it can be seen that a greater proportion of the observed population are of pre-school and primary school age, than the proportion of the study area population, while the opposite is the case for secondary school age children. It should be remembered however, that because virtually no school age children were observed during school hours in this survey there is a favourable bias towards pre-school children.

Location

Table 8.6 shows the age and sex of the children by the section of route on which they were observed.

Table 8.6: Age and sex of the children observed for each of the 5 sections in Nelson schoolday survey.

	Sex		Age			
	Boys	Girls	Pre-school	Primary school	Secondary school	All Children
Section 1	596	440	410	395	231	1036
2	288	215	173	155	175	503
3	399	199	156	314	128	598
4	487	306	323	282	188	793
5	171	84	61	72	122	255
Total	1941	1244	1123	1218	844	3185

It can be seen from this table that different numbers and kinds of children were observed on each of the 5 sections. On Sections 3 and 5 the ratio of boys to girls observed was about 2.0, while on the other three sections it ranged from 1.3 to 1.6. This difference is very unlikely to have arisen by chance (χ^2 with 4 degrees of freedom = 20.9, p<0.001). Section 3 contributes no less than 8.6 to the χ^2 value of 20.9.

On Sections 3 and 5, 26.1% and 23.9% respectively of the children observed were of pre-school age, while on the other three sections this figure ranged from 34.4% to 40.7%. Cn Section 3, the proportion of primary school children observed was 52.5%, whereas on the other 4 sections it ranged only from 28.2% to 38.1%. Finally, on Section 5 the proportion of secondary school children observed was 47.8%, whereas on the other 4 sections it ranged only from 21.4% to 34.8%. These differences are very unlikely to have arisen by chance (χ^2 with 8 degrees of freedom = 154.1, p<0.001). The fact that Sections 3 and 5 differ from the others in the above respects is confirmed by the fact that they contribute no less than 51.6 and 59.1 respectively to the χ^2 value of 154.1.

The differences described above could arise because of the different characteristics of each of the sections, such as the number of shops and play areas, the amount of traffic, or their proximity to residential areas, and the effect that these have upon making certain sections of the road more or less attractive to different groups of children.

Table 8.7 shows the age and sex of the children observed by type of road for the Nelson schoolday survey.

Table 8.7: Age and sex of the children observed by type of road for the Nelson schoolday survey.

Type of road	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Main roads	578	381	316	307	336	959
Other roads	1363	863	807	911	508	2226
Total	1941	1244	1123	1218	844	3185

It can be seen that in total 30.1% of the children were observed on main roads, while the remainder were observed on other roads. On main roads and other roads the ratios of boys to girls observed were very similar (about 1.5 and 1.6 respectively). In terms of age, a smaller proportion of children observed on main roads were of pre-school and primary school age (33.0% and 32.0% respectively) than on other roads (36.3% and 40.9% respectively), while a greater proportion of children observed on main roads were of secondary school age (35.0%) than on other roads (22.8%). This indicates either that pre-school and primary school children are not allowed to use main roads as much as secondary school children, or that they choose to do so less. It is perhaps surprising that primary school children are underrepresented on main roads compared to other roads to a greater degree than pre-school children, though this is possibly because a greater proportion of pre-school children were observed walking or on errands and a smaller proportion playing than primary school children (see Table 8.17). It is shown in Section 8.4 that a smaller proportion of children observed on main roads were playing than walking or on errands.

Time of day

Table 8.8 shows the age and sex breakdowns for each of the time periods of the day.

Table 8.8: Age and sex of the children observed for each of the 5 periods of the day in the Nelson schoolday survey.

Time	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
09.00-10.30	119	90	193	6	10	209
10.45-12.15	115	105	214	1	5	220
14.00-15.30	115	118	219	7	7	233
16.45-18.15	642	396	265	466	307	1038
18.30-20.00	950	535	232	738	515	1485
Total	1941	1244	1123	1218	844	3185

Due to the structure and nature of this survey, there are large differences in the numbers of children observed during the first three time periods of the day compared to the final two periods. For the same reason there are also appreciable differences in the proportions of each sex and age group observed during the first three periods of the day compared to the final two. During the first three periods of the day the ratio of boys to girls observed ranged from about 1.0 to 1.3, whereas during the final two periods of the day it ranged from 1.6 to 1.8. This difference is very unlikely to have arisen by chance (χ^2 with 4 degrees of freedom = 27.4, $p<0.001$).

In terms of age, it can be seen that for the first 3 periods of the day school age children contribute only negligible percentages to the total number of children observed. However, in the last two periods of the day, school age children accounted for a very large proportion of all children observed. During Period 4 pre-school age children accounted for 25.5% of the children observed, whereas in Period 5 they only accounted for 15.6%. The proportions of primary and secondary children observed in Period 4 compared to Period 5 were correspondingly higher. These differences are very unlikely to have arisen by chance (χ^2 with 2 degrees of freedom = 38.7, $p<0.001$). The reason for this difference is most likely that pre-school age children are much more likely to be prevented by their parents from being outside during the final surveyed period of the day (6.30pm to 8.00pm) than primary or secondary school age children.

8.3.2 <u>The Nelson school holiday survey</u>. During the 5 weekdays over which this survey was undertaken, a total of 4540 children were observed on the streets. This is substantially more than were observed in the Nelson schoolday survey. This difference is largely because in that survey very few school age children were observed during school hours, while in the present survey children of all ages were observed throughout the whole surveyed period. In this survey 44.2% of the children were observed on the MOBS route. The remaining 55.8% were observed in the SOBS data collection areas. These figures are similar to those of the Nelson schoolday survey. Table 8.9 shows the number of children of each age and sex observed, and the number of children of each age and sex living in the study area.

Table 8.9: Age and sex of the children observed in the Nelson school holiday survey (obs.), and the number of children of each age and sex living in the study area as a whole (pop.).

	Sex				Total	
	Boys		Girls			
Age	Obs.	Pop.	Obs.	Pop.	Obs.	Pop.
Pre-school	568	1192	558	1083	1126	2275
Primary	1577	1335	858	1189	2435	2524
Secondary	652	1124	327	1029	979	2153
Total	2797	3651	1743	3301	4540	6952

In terms of the sex of the children observed it can be seen that there are a number of similarities between the results of this survey and those for the Nelson schoolday survey. In both surveys about three-fifths of the children observed were boys. Also, in both surveys, the proportion of boys observed varies with age, with about half of the pre-school children observed boys, and rather higher proportions of primary and secondary school children. The only differences between the two surveys are that in the schoolday survey a slightly larger proportion of the secondary school and a slightly smaller proportion of the primary school children observed were boys compared to the school holiday survey. Finally, taking account of the proportions of boys and girls in the study area population, it can be shown that in both surveys boys were overrepresented on the streets and girls underrepresented. However, while this was the case for school age children, pre-school boys and girls were observed on the streets in about the same proportions as they occur in the population.

In terms of age a greater proportion of the observed population were of primary school age in the school holiday survey compared to the schoolday survey, while the opposite was the case for both pre-school and secondary secondary school children. It can be seen that about the same number of pre-school children were observed in this survey as in the Nelson schoolday survey. However, there were about twice as many primary school children, and about 16% more secondary school children observed. This difference is mainly due to there having been virtually no school age children observed in the Nelson schoolday survey during school hours. It is not known exactly why there were relatively more primary school children observed in this survey compared to the Nelson schoolday survey, than secondary school children. Part of the reason might be that, in the Nelson schoolday survey, most of the school age children were observed in the evening periods, at times when a greater proportion of primary school children compared to secondary school children might be forbidden by their parents to be outside.

Location

Table 8.10 shows the age and sex of the children observed on each of the 5 sections of the route.

Table 8.10: Age and sex of the children observed for each of the 5 sections in the Nelson school holiday survey.

	Sex		Age			
	Boys	Girls	Pre-school	Primary school	Secondary school	All Children
Section 1	876	515	356	807	228	1391
2	371	296	189	296	182	667
3	524	273	218	414	165	797
4	780	534	317	738	259	1314
5	246	125	46	180	145	371
Total	2797	1743	1126	2435	979	4540

As was the case in the Nelson schoolday survey, it can be seen from the table that different proportions of children were observed on each of the 5 sections. However, the rank order (of the proportion of children observed on each section) is the same in this survey as in the Nelson schoolday survey, and a roughly similar proportion of children were observed on each section in both surveys.

On Section 2 the ratio of boys to girls observed was only 1.3, whereas on the other 4 sections it ranged from 1.5 to 2.0. This difference is very unlikely to have arisen by chance (χ^2 with 4 degrees of freedom = 23.2, p<0.001). The fact that Section 2 differs in this respect from the other 4 sections is confirmed by the fact that it contributes no less than 10.1 to the χ^2 value of 23.2. Comparison of the ratio of boys to girls observed on each section in this survey with the same ratios for the Nelson schoolday survey shows that in most cases they are very similar, though for Section 1 the ratio is higher in the holiday survey than in the schoolday survey.

On Section 5 only 12.4% of the observed children were of pre-school age, while on the other 4 sections this ranged from 24.1% to 28.3%. Also on Section 5, 39.1% of the children observed were of secondary school age, while on the other 4 sections this ranged from 16.4% to 27.3%. These differences are unlikely to have arisen by chance (χ^2 with 8 degrees of freedom = 30.9, $p<0.001$). As was the case in the Nelson schoolday survey, it is likely that these differences arise to some extent from the different characteristics or nature of the sections which attract different groups of children to use them. In both of the surveys the hiɓhest proportion of secondary school children and the lowest proportion of pre-school children were observed on Section 5. Also the lowest proportions of primary school age children were observed on Sections 2 and 5 in both surveys. Finally, in the holiday survey, the highest proportions of primary school children were observed on Sections 1 and 4, whereas in the schoolday survey the highest proportion of primary school children was observed on Section 3.

Table 8.11 shows the age and sex of the children observed by type of road for the Nelson school holiday survey.

Table 8.11: Age and sex of the children observed by type of road for the Nelson school holiday survey.

Type of road	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Main roads	751	533	246	657	381	1284
Other roads	2046	1210	880	1778	598	3256
Total	2797	1743	1126	2435	979	4540

In total a very similar proportion of children were observed on main roads in this survey (28.3%) as in the Nelson schoolday survey. On main roads the ratio of boys to girls observed was only 1.4, while on other roads it was 1.7. These figures differ from those of the Nelson schoolday survey where the ratios of boys to girls observed for main and other roads were about the same. In terms of age, pre-school and primary school children were both underrepresented on main roads compared to other roads, while secondary school children were overrepresented. This is the same overall pattern as that observed in the Nelson schoolday survey, though unlike in that survey pre-school children are underrepresented on main roads compared to other roads to a greater degree than primary school children. This might be because in this survey a larger proportion of the pre-school children were observed playing compared to primary school children, while in the schoolday survey the opposite was the case (see Tables 8.17 and 8.20).

Time of day

Table 8.12 shows the age and sex breakdowns for each of the time periods of the day.

Table 8.12: Age and sex of the children observed for each of the 5 periods of the day in the Nelson school holiday survey.

Time	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
09.00-10.30	170	153	85	167	71	323
10.45-12.15	537	365	255	469	178	902
14.00-15.30	810	464	293	687	294	1274
16.45-18.15	572	418	284	518	188	990
18.30-20.00	708	343	209	594	248	1051
Total	2797	1743	1126	2435	979	4540

This shows that during the day there were different numbers of children using the roads and that least children were observed in the morning periods (especially before 10.30am), and most in the early afternoon and evening. This pattern differs quite considerably from the Nelson schoolday survey, as there were many more children observed during the first three periods of the day than in that survey. It is also noticeable that during Periods 4 and especially Period 5 there were substantially more children observed in the Nelson schoolday survey than in the school holiday survey. This might be because on schooldays, school age children have to concentrate all their non-school-related outdoor activities into the evening period, while on the school holidays they have the whole day for such purposes.

The ratio of boys to girls observed ranges from about 1.1 during Period 1 to about 2.1 during Period 5. The differences between the ratios of boys to girls observed for each of the periods are very unlikely to have arisen by chance (χ^2 with 4 degrees of freedom = 35.9, $p<0.001$). The fact that Periods 1 and 5 differ substantially from the others in this respect is confirmed by the fact that they contribute no less than 11.0 and 15.0 respectively to the overall χ^2 value of 35.9. It was also shown to be the case in the Nelson schoolday survey that the highest ratio of boys to girls observed was during Period 5.

In terms of age it can be seen that the proportions of pre-school children observed ranged from 19.9% during Period 5 to 28.7% during Period 4. The proportions of school age children observed are highest during Periods 3 and 5. These differences are unlikely to have arisen by chance (χ^2 with 8 degrees of freedom = 32.8, $p<0.001$). The fact that there are a low proportion of pre-school age children observed in the final period of the day was also shown to be the case in the Nelson schoolday survey, and the reasons for this are likely to be the same as in that survey. It was also the case in the Nelson schoolday survey that a higher proportion of school age children were observed in Period 5 than in any of the other periods.

8.3.3 The Bristol school holiday survey. During the 5 weekdays in the school holidays over which this survey was undertaken a total of 2890 children were observed. Of these 1789 (61.9%) were observed on the MOBs route. The total number of children observed is appreciably less than the total in each of the two Nelson surveys. Some of this difference can be explained by the fact that the observation area in Nelson is bigger than in Bristol. While the length of the MOBs route is the same in both areas, the length of road in the SOBs data collection areas is greater in Nelson than in Bristol because the road network is denser. In the Nelson area the length of road in the SOBs data collection area is 16.39km, while in the Bristol area it is only 8.19km. This means that in the Nelson and Bristol school holiday surveys respectively 157 and 134 children were observed per kilometre of road in the SOBs areas, and 365 and 325 children respectively were observed per kilometre on the MOBs routes. Thus when the size of observation area is taken into account the difference between the number of children observed on the two holiday surveys is not so large.

Table 8.13 shows the number of children of each age and sex observed, and the number of children of each age and sex living in the Bristol study area.

Table 8.13: Age and sex of the children observed in the Bristol school holiday survey (obs.), and the number of children of each age and sex living in the study area as a whole (pop.).

	Sex				Total	
	Boys		Girls			
Age	Obs.	Pop.	Obs.	Pop.	Obs.	Pop.
Pre-school	336	880	300	873	636	1753
Primary	733	1268	565	1228	1298	2496
Secondary	586	1401	370	1262	956	2663
Total	1655	3549	1235	3363	2890	6912

A slightly lower proportion of the children observed in this survey were boys than in the Nelson school holiday survey. However, in both surveys the proportion of boys observed varies with age, with about half of the pre-school children observed boys, and higher proportions of primary and secondary school children. The only appreciable difference between the two surveys was that in the Bristol survey a slightly smaller proportion of the school age children observed were boys than in the Nelson survey. Taking account of the proportions of boys and girls in the study area population it can be shown that in both surveys boys were overrepresented on the streets and girls underrepresented, though to a slightly lesser extent in the Bristol survey than in the Nelson survey. In both surveys it was boys of school age who were overrepresented on the roads, relative to their proportion of the population, and girls of school age who were underrepresented. Boys and girls of pre-school age were observed on the roads in about the same proportions as they occur in the population.

In the Nelson school holiday survey a substantially larger proportion of the children observed were of primary school age and a lower proportion were of secondary school age than in the Bristol school holiday survey. In both surveys primary school children were overrepresented on the roads relative to their proportion of the population, while pre-school and secondary school children were underrepresented, though in each case the differences between the proportion of observed children and the proportion of children in the population are greater for Nelson than for Bristol.

Location

Table 8.14 shows the age and sex breakdowns for each of the five sections in the Bristol school holiday survey.

Table 8.14: Age and sex of the children observed for each of the 5 sections in the Bristol school holiday survey.

	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Section 1	464	339	195	427	181	803
2	687	600	280	551	456	1287
3	188	122	44	147	119	310
4	138	85	51	75	97	223
5	178	89	66	98	103	267
Total	1655	1235	636	1298	956	2890

As in both of the other surveys it can be seen that there were some appreciable differences in the numbers of children observed on each section. However, these differences cannot be compared between this survey and the Nelson school holiday survey, because the division of the two routes into sections does not reflect any common categorisation by type of road or type of area.

The ratio of boys to girls observed ranged from 1.1 on Section 1 to 2.0 on Section 5. The differences between the proportions of boys and girls observed on each of the sections are very unlikely to have arisen by chance (χ^2 with 4 degrees of freedom = 20.7, $p<0.001$). Sections 1 and 5 contribute no less than 7.9 and 9.6 respectively to the χ^2 value of 20.7.

As well as differences between the proportions of each sex observed on each of the sections there were also differences in the proportions in each age group. On Section 3 only 14.2% of the observed children were of pre-school age, whereas on the other 4 sections this ranged from 21.8% to 24.7%. On Sections 4 and 5 only 33.6% and 36.7% of the children observed were of primary school age, whereas on the other three sections the figure ranged from 42.8% to 53.2%. On Section 1, only 22.5% of the children observed were of secondary school age, while on the other four sections this ranged from 35.4% to 43.5%. These differences are very unlikely to have arisen by chance (χ^2 with 8 degrees of freedom = 75.4, p<0.001).

As was the case in the other two surveys, it is likely that the differences in the proportions of the sex and age groups using each of the sections arises to some extent from the different characteristics or nature of the sections (such as the number of shops and play areas, the volume and type of traffic and their proximity to residential areas) which attract different groups of children to use them. However, the specific reasons for these differences are not known.

Table 8.15 shows the age and sex of the children observed by type of road for the Bristol school holiday survey.

Table 8.15: Age and sex of the children observed by type of road for the Bristol school holiday survey.

Type of road	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Main roads	386	238	172	228	224	624
Other roads	1269	997	464	1070	732	2266
Total	1655	1235	636	1298	956	2890

It can be seen that in total 21.6% of the children were observed on main roads. This is substantially less than the figure for the Nelson school holiday survey, though this could reflect differences in the lengths of main road in the two areas. On main roads the ratio of boys to girls observed was about 1.6, whereas on other roads it was only about 1.3. In the Nelson school holiday survey the ratio was higher on other roads than on main roads. In terms of age, on main roads pre-school and secondary school children were overrepresented compared to other roads, while primary school children were underrepresented. Again this pattern differs from the Nelson school holiday survey, where pre-school children were underrepresented on main roads compared to other roads. It is possible that part of the reason for this difference is that a greater proportion of pre-school children were observed accompanied by adults in the Bristol school holiday survey compared to the Nelson school holiday survey (see Tables 8.27 and 8.28).

Time of day

Table 8.16 shows the age and sex breakdowns for each of the time periods of the day in the Bristol school holiday survey.

Table 8.16: Age and sex of the children observed for each of the 5 periods of the day in the Bristol school holiday survey.

Time	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
09.00-10.30	211	127	111	160	67	338
10.45-12.15	351	317	159	272	237	668
14.00-15.30	395	299	164	334	196	694
16.45-18.15	317	226	118	240	185	543
18.30-20.00	381	266	84	292	271	647
Total	1655	1235	636	1298	956	2890

In both the surveys the lowest proportion of children observed was during Period 1, and the highest proportion during Period 5. However, in the Bristol survey there were a substantially larger proportion of children observed in the morning periods compared to Nelson, and a lower proportion of children observed in the periods after lunch.

During Period 1 the ratio of boys to girls observed was about 1.7, whereas during the other 4 periods it ranged from 1.1 to 1.4. These differences are unlikely to have arisen by chance (χ^2 with 4 degrees of freedom = 10.7, $p<0.05$). The pattern found in this survey is different from that of the Nelson school holiday survey where it was shown that the highest ratio of boys to girls observed was during

Period 5 and the lowest during Period 1.

The proportions of pre-school children observed ranged from 13.0% during Period 5 to 32.8% during Period 1, while the proportions of secondary school children observed ranged from 19.8% during Period 1 to 41.9% during Period 5. These differences are very unlikely to have arisen by chance (χ^2 with 8 degrees of freedom = 88.3, $p<0.001$). The pattern found in this survey is again different to that of the Nelson survey. During the 5 surveyed periods the proportion of pre-school children observed varies more in the Bristol survey than in the Nelson survey. In both cases the smallest proportion of pre-school children was observed in Period 5, though this proportion is substantially lower in the Bristol survey compared to the Nelson survey. It is also true that the proportion of secondary school children observed in each period varies more in the Bristol survey than in the Nelson survey. In Period 5 the proportion of secondary school children observed in the Bristol survey is almost twice that of the Nelson survey.

8.3.4 Summary. A number of important differences in the patterns of use made of the roads by children have been identified firstly between schooldays and school holidays in the Nelson study area, and secondly between the Bristol and Nelson areas in school holidays. These are summarised here.

Schooldays and school holidays in Nelson

In the school holiday survey a larger number of children were observed on the roads than in the schoolday survey. In the schoolday survey a greater proportion of the children observed were of pre-school and secondary school age than in the holiday survey, while the opposite was the case for primary school children. About the same number of pre-school children were observed in both surveys, whereas about twice as many primary school children and 16% more secondary school children were observed in the school holiday survey compared to the schoolday survey. In terms of location the ratio of boys to girls observed is higher on Section 1 in the holiday survey than in the schoolday survey. On the other sections the ratios are similar between the two surveys. In the holiday survey the highest proportion of primary school children were observed on Sections 1 and 4, whereas in the schoolday survey the highest proportion were observed on Section 3. In the holiday survey the ratio of boys to girls observed was higher on other roads than on main roads, whereas in the schoolday survey no such difference was apparent. In terms of time of day, the pattern in the schoolday survey is quite different from the holiday survey, mainly because in the former very few school age children were observed during school hours, while in the latter children of all ages were observed throughout the whole surveyed period. However, there were also differences in the final two periods of the day, where there were a larger number of children observed in the schoolday survey than in the holiday survey.

Nelson and Bristol in the school holidays

In the Nelson survey more children were observed than in the Bristol survey. It can be shown that this is still the case when allowance is made for the differences in size of the surveyed areas. In the Bristol survey a smaller proportion of the school age children observed were boys than in the Nelson survey. A substantially larger proportion of the children observed in the Nelson survey were of primary school age, and a smaller proportion of secondary school age, than in the Bristol survey. In the Bristol survey the ratio of boys to girls observed was higher on main roads than on other roads, while in the Nelson survey the opposite was the case. In the Bristol survey pre-school children were overrepresented on main roads compared to other roads, while in the Nelson survey they were underrepresented. In the Bristol survey a greater proportion of children were observed in the morning periods compared to the Nelson survey, and a lower proportion in the afternoon periods. Finally, the proportions of children of each age and sex observed in different periods of the day differs appreciably between the two surveys.

8.4 Activity

This section will examine some of the activities in which various groups of children were observed, and will also consider variations in these by location and time of day.

8.4.1 The Nelson schoolday survey. Table 8.17 shows the proportions of children of each age and sex group observed while involved in certain types of activity. For the purposes of this and subsequent tables some of the activity groups listed ~~in~~ Appendix C.1 have been combined.

Table 8.17: Age and sex of the children observed by type of activity in the Nelson schoolday survey (all figures except the base are percentages).

Activity	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Walking/ errand	19.5	22.4	20.8	15.6	27.7	20.7
Playing	58.4	61.2	57.1	70.5	46.7	59.4
Cycling	2.6	0.8	0.1	1.2	5.3	1.9
'Playing cycling'	10.9	1.5	1.5	9.3	11.8	7.2
In pram	3.6	7.9	15.0	0.0	0.0	5.3
Other	5.0	6.2	5.5	3.4	8.5	5.5
Base	1941	1244	1123	1218	844	3185

This shows that the most frequently observed activity in this survey was play. Of all the children observed, 66.6% were involved in some type of play activity (either on foot or bicycle). A further 20.7% of the children were observed while walking/on errands. In total 9.1% of children were observed on bicycles, though about four-fifths of these were playing on bicycles, as opposed to using them for travel purposes.

There were some differences in the proportions of each sex observed in particular activities. A much larger proportion of boys than girls were observed on bicycles (13.5% and 2.3% respectively). However, similar proportions of boys and girls were observed walking/on errands (19.5% and 22.4% respectively) and playing (58.4% and 61.2% respectively).

There were also some differences in observed activity between the three age groups. Smaller proportions of pre-school and secondary school children were observed playing (57.1% and 46.7% respectively) compared to primary school children (70.5%). The reasons for these differences might be that in general parents are less willing to allow pre-school children to use the roads for play than they are primary and secondary school age children. Secondary school children, although probably being the most independant of the three age groups about where and when they play, perhaps choose to play on the streets less than primary school children because they are starting to behave more like young adults and other types of activity start to appeal to them more. It is also the case that a larger proportion of secondary school age children were observed cycling (17.1%), than primary school children (10.5%), and pre-school children (1.6%). Again, this is probably largely because parents in general consider it unsafe to allow very young children to own and use bicycles. Finally, a larger proportion of secondary school children were observed walking/on errands (27.7%), than pre-school children (20.8%) and primary school children (15.6%).

Location

Table 8.18 shows some of the more common types of activity of the children by the section of route on which they were observed.

Table 8.18: Activity of the children observed by the section of road in the Nelson schoolday survey (all figures except the base are percentages).

Activity	Section					Total
	1	2	3	4	5	
Walking/ errand	23.5	31.8	10.2	16.3	25.5	20.7
Playing	61.1	45.4	65.9	69.9	32.6	59.4
Cycling	1.2	3.8	1.8	1.1	3.9	1.9
'Playing cycling'	3.1	5.2	15.1	4.3	18.8	7.2
In pram	4.2	6.4	3.3	5.9	9.8	5.3
Other	6.9	7.4	3.7	2.5	9.4	5.5
Base	1036	503	598	793	255	3185

As can be seen from this table, the proportions of children observed in different activities varies between sections. This variation seems to be related, at least in part, to the characteristics of the sections. For instance, the lowest proportions of children observed playing were on Sections 2 and 5. A part of Section 2 is along the main Leeds Road which along with parts of some of the side roads adjoining it are no doubt unattractive to children wanting to play. Also along the final part of this section, there are areas of open space nearby in which children could play in preference to the road (Walton Lane), which contains just enough fast-moving traffic to make it not worthwhile trying to use it as a play space. Section 5 is along main roads all the way, and even some of the side roads along these (SOBs data collection areas) contain roads on which traffic is sufficiently frequent to put off certain types of play activities. In Sections 1, 3 and 4 there are larger areas in which it would be reasonably safe for children to play on the roads, with only the minor inconvenience of the occasional car forcing them to move. The highest proportions of children observed walking/on errands were on those sections where the proportion of children observed playing was lowest. Sections 3 and 5 contain the highest proportions of children observed cycling.

Only 28.4% of the children observed on main roads were playing, while on other roads, 72.8% of children were observed playing. A greater proportion of children observed on main roads were walking/on errands (38.1%), than those observed on other roads (12.7%). Also, a greater proportion of children observed on other roads were 'playing cycling' (7.7%) than children observed on main roads (3.5%), while the opposite was the case for children observed cycling (1.2% of children observed on other roads, and 6.2% of children observed on main roads). These figures show that the perceived danger of main roads compared to other types of roads is sufficient to inhibit the amount of play-type activity which takes place on them.

Time of day

Table 8.19 shows the same activities as in Table 8.18, by the time of day at which the children were observed undertaking them.

Table 8.19: Activity of the children observed by the period of the day in the Nelson schoolday survey (all figures except the base are percentages).

Activity	Period					Total
	1	2	3	4	5	
Walking/ errand	35.8	25.0	26.2	25.7	13.5	20.7
Playing	33.5	46.8	48.5	54.1	70.4	59.4
Cycling	0.0	0.0	0.0	3.6	1.6	1.9
'Playing cycling'	1.0	0.0	0.4	8.1	9.6	7.2
In pram	22.5	22.7	17.2	1.9	0.7	5.3
Other	7.2	5.5	7.7	6.6	4.2	5.5
Base	209	220	233	1038	1485	3185

It can be seen that there were large differences in the proportions of children undertaking certain activities between the first 3 periods of the day, and the last two. In particular, virtually no children were observed using a bicycle for any purpose in the first 3 periods of the day (when most of the children observed were of pre-school age) while in the last two many more children were observed using them, though largely for play than for other purposes. Only a very small proportion of the children observed in the final 2 periods of the day were in prams, compared to the first 3 periods. This is because a very high proportion of pre-school children were observed in the first 3 periods of the day compared to later on. Although a substantial proportion of children were observed playing in the first three periods of the day (between 33.5% and 48.5%), the proportions in the last two periods, especially the final period of the day, were higher (54.1% and 70.4%). The proportion of children observed walking/on errands is highest in Period 1 and lowest in Period 5. During Periods 2, 3 and 4 the proportions of children observed walking/on errands are about the same. This might be because in Periods 2 and 3 a lot of pre-school age children would be taken on errands with their parents, while in Period 4 it is possible that a lot of school age children arriving home from school, are either sent on errands by their parents (e.g to the shops) or go of their own accord. During Period 4 (at least at the beginning) it is likely that a number of shops which might attract children will still be open.

8.4.2 The Nelson school holiday survey. Table 8.20 shows the proportions of children of each age and sex group involved in each type of activity.

Table 8.20: Age and sex of the children observed by type of activity in the Nelson school holiday survey (all figures except the base are percentages).

Activity	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Walking/errand	24.3	30.5	24.2	23.3	38.0	26.7
Playing	49.6	51.5	60.4	54.7	27.8	50.2
Cycling	5.4	1.1	0.4	3.8	7.6	3.8
'Playing cycling'	8.5	1.1	2.1	7.4	5.5	5.7
In pram	1.3	2.1	6.3	0.0	0.0	1.6
Other	10.9	13.7	6.6	10.8	21.1	12.0
Base	2797	1743	1126	2435	979	4540

This shows that the most frequently observed activity in this area was play of some sort (55.9% of the total were observed playing on foot or on bicycles). The next most frequently observed activity was children walking/on errands, which involved 26.7% of the total. These two figures differ from the Nelson schoolday survey, where a larger proportion of children were observed playing (66.6%) and a smaller proportion walking/on errands (20.7%). This could be because a large proportion of the total number of children observed in the schoolday survey were observed in the evening periods (during the day most school age children were at school). At this time of day there is likely to be a relatively smaller proportion of errand type journeys taking place because the majority of shops will be closed. A similar proportion of children were observed on bicycles in this survey (9.5%) as in the schoolday survey, though a smaller proportion of these were playing on bicycles (about three-fifths), most likely for the same reasons as above.

There were some differences in the sex of the children observed undertaking certain activities. As in the Nelson schoolday survey a much greater proportion of boys were observed using bicycles for all purposes than girls (13.9% and 2.2% respectively). Also in both surveys about the same proportions of boys were observed playing as girls. However, the difference between the proportions of girls and boys observed walking/on errands in this survey (30.5% and 24.3% respectively) is greater than that found in the Nelson schoolday survey.

In this survey a very small proportion of secondary school children (27.8%) were observed playing compared to primary (54.7%) and especially pre-school children (60.4%). This differs from the Nelson schoolday survey where the proportions of primary and secondary school children observed playing were substantially higher. The reasons for these differences are most likely the same as described above, that in the schoolday survey, because school age children were only observed in the evening period, when errand type journeys were less likely to occur, their overall proportion of play was higher. As in the Nelson schoolday survey, a larger proportion of secondary school children were observed cycling (13.1%) compared to primary and pre-school children (11.2% and 2.5% respectively). Finally, as was also the case in the Nelson schoolday survey, a larger proportion of secondary school children were observed walking/on errands (38.0%) than primary and pre-school children (23.3% and 24.2% respectively).

Location

Table 8.21 shows some of the more common activities of the children by the section of the route on which they were observed.

Table 8.21: Activity of the children observed by the section of road in the Nelson school holiday survey (all figures except the base are percentages).

Activity	Section					Total
	1	2	3	4	5	
Walking/ errand	31.5	32.7	20.1	20.9	32.7	26.7
Playing	49.4	35.1	51.4	64.3	29.1	50.2
Cycling	2.6	6.4	4.5	2.1	7.5	3.8
'Playing cycling'	4.0	4.3	10.5	3.4	12.4	5.7
In pram	1.1	2.2	1.3	1.2	4.3	1.6
Other	11.4	19.3	12.2	8.1	14.0	12.0
Base	1391	667	797	1314	371	4540

It can be seen, as was the case in the Nelson schoolday survey, that the proportions of children observed in different activities varies between sections and that the sections containing the lowest proportions of children observed playing were Sections 2 and 5. It is likely therefore, that the reasons given for this in Section 8.4.1 also apply here. It is also true here that the sections with the highest proportions of children walking/on errands were those where the proportion of children observed playing was lowest (Sections 2 and 5). Finally, it is again also true here, as in the Nelson schoolday survey, that there were higher proportions of children obsreved cycling (for all purposes) on Sections 3 and especially 5 than on the other sections.

As was the case in the Nelson schoolday survey a lower proportion of children observed on main roads were playing (19.9%) than children observed on other roads (62.3%). It is also the case in this survey, as in the Nelson schoolday survey, that a greater proportion of children observed on main roads were walking/on errands (48.6%) than children observed on other roads (17.7%). Finally, a greater proportion of children observed on other roads were 'playing cycling' (6.8%) than children observed on main roads (3.0%), while the opposite was the case for children observed cycling (2.8% of children observed on other roads, and 6.3% of children observed on main roads). The order of magnitude of all of these differences between main and other roads is very similar between the two surveys.

Time of day

Table 8.22 shows the same activities as in Table 8.21, by the time of day at which the children were observed undertaking them.

Table 8.22: Activity of the children observed by the period of the day in the Nelson school holiday survey (all figures except the base are percentages).

Activity	Period					Total
	1	2	3	4	5	
Walking/ errand	52.9	33.1	22.1	27.4	18.1	26.7
Playing	19.2	40.1	53.7	50.9	63.9	50.2
Cycling	2.5	3.0	4.9	4.1	3.0	3.8
'Playing cycling'	1.5	5.0	7.8	6.1	4.7	5.7
In pram	5.9	4.1	0.9	0.5	0.0	1.6
Other	18.0	14.7	10.6	11.0	10.3	12.0
Base	323	902	1274	990	1051	4540

This shows that there were differences in the numbers of children observed in different types of activity at different times of the day. As in the Nelson schoolday survey a lower proportion of children were observed playing during Period 1 than in any of the other periods, while the highest proportion of children observed playing was during Period 5. However, in the Nelson schoolday survey both of these figures were substantially higher than in the school holiday survey. It is only during Period 3 that a greater proportion of children were observed playing in the holiday survey compared to the schoolday survey. The table shows that children who go out early in the day are much more likely to be going out walking or on an errand than those who go out later. This was also true in the Nelson schoolday survey, though the proportion of children walking/on errands in Period 1 was higher in the holiday survey than in the schoolday survey. In both surveys, during the first 2 periods of the day a larger proportion of children were seen in prams, than over the remainder of the day. However, in the Nelson school holiday survey during Period 3 only a very small proportion of children were observed in prams, while in the schoolday survey the proportion was still quite substantial. Very few children were observed in prams in the last 2 periods of the day, perhaps because children this young were all in bed. Unlike in the schoolday survey, where virtually no children were observed cycling in the first 3 periods of the day, in this survey Period 3 had the highest proportion of children observed cycling (12.7%). The proportion of children observed cycling was very low during Period 1 in both surveys.

8.4.3 The Bristol school holiday survey. Table 8.23 shows the age and sex of the children observed in various types of activity. This table contains two further activity types, not included in the Nelson survey analyses. These are riding a BMX bicycle, and using a BMX bicycle for play purposes. Use of BMX bicycles was not recorded in Nelson due to their seemingly infrequent use.

Table 8.23: Age and sex of the children observed by type of activity in the Bristol school holiday survey (all figures except the base are percentages).

Activity	Sex		Age			All Children
	Boys	Girls	Pre-school	Primary school	Secondary school	
Walking/errand	17.9	32.6	25.2	21.6	27.1	24.2
Playing	34.3	36.6	30.0	42.9	28.2	35.4
Cycling	3.6	1.6	0.3	1.8	5.6	2.7
BMX	2.1	0.7	0.2	1.2	2.8	1.5
'Playing cycling'	8.6	4.3	2.8	8.0	7.6	6.7
'Playing BMX'	12.3	1.1	0.9	9.9	8.8	7.5
In pram	4.2	3.3	17.5	0.0	0.0	3.8
Other	17.0	19.8	23.1	14.6	19.9	18.2
Base	1655	1235	636	1298	956	2890

As in the Nelson school holiday survey, the most common activities observed were play (49.6% were observed playing on foot and on bicycles) and walking/on errands (24.2%). However, while similar proportions of children were observed walking/on errands in the two surveys, smaller proportion of children were observed playing in this survey compared to the Nelson school holiday survey. A greater proportion of children in the Bristol survey were observed using a bicycle (18.4% in total, of which about four-fifths were observed playing on their bicycles) compared to the Nelson survey (9.5%). The major difference in the levels of cycling between the two areas are when bicycles are used for play purposes (5.7% in Nelson and 14.2% in Bristol). The proportions of children observed using bicycles for purposes other than play are very similar in the two surveys (3.8% in

Nelson and 4.2% in Bristol). It is possible that this difference could be related to the relative affluence of the Bristol area compared to Nelson, or perhaps to topographical differences, notably the large number of hills in Nelson. The table shows that in the Bristol study area a greater proportion of children were using BMX bicycles for playing than other bicycles, while for cycling (for purposes other than play) a greater proportion of children were using other bicycles, than BMX bicycles. This is perhaps to be expected, as BMX bicycles are designed for play, and are not really an efficient method of getting about.

As in the Nelson school holiday survey, a much greater proportion of boys were observed cycling compared to girls (26.6% and 7.7% respectively), though the magnitude of this difference is not as great in the Bristol survey (about 3.5 times) as in the Nelson survey (about 6.3 times). In the Bristol survey, again as in the Nelson school holiday survey, a greater proportion of girls (32.6%) were observed walking/on errands than boys (17.9%) though in this case the magnitude of the difference is greater in the Bristol survey (1.8) than in the Nelson survey (1.3). Finally, in both surveys about the same proportions of boys were observed playing (on foot) as girls, though the actual proportions differ between the surveys.

A higher proportion of primary school children (42.9%) were observed playing, than pre-school and secondary school children (30.0% and 28.2% respectively). The proportion of secondary school children observed playing in this survey is similar to that observed in the Nelson school holiday survey. However, the proportions of primary and particularly pre-school children observed playing are both much lower in this survey than in the Nelson school holiday survey. This might be because parents are more restrictive about very young children using the roads for play purposes in the Bristol area compared to the Nelson area, perhaps because they perceive them as being more dangerous, or because play spaces other than the roads are more available in the Bristol area than in Nelson, or are more attractive to children as play areas. As in the Nelson survey a higher proportion of secondary school age children were observed cycling than primary or pre-school children. For all three age groups the proportion observed cycling in Bristol is higher than in Nelson, being about 1.9 times the level for school age children, though only about 1.7 times the level for pre-school children. Finally, similar proportions of pre-school and primary school children were observed walking/on errands in this survey as in the Nelson school holiday survey, though the proportion of secondary school children observed walking/on errands is appreciably less than that in the Nelson school holiday survey.

Location

Table 8.24 shows some of the more common activities which were observed on each of the sections of the route.

Table 8.24: Activity of the children observed by the section of road in the Bristol school holiday survey (all figures except the base are percentages).

Activity	Section 1	2	3	4	5	Total
Walking/ errand	26.9	22.1	20.0	25.6	30.0	24.2
Playing	41.3	31.8	34.6	30.0	38.9	35.4
Cycling	3.2	1.4	2.3	7.2	4.5	2.7
BMX	1.6	1.2	1.3	1.3	2.6	1.5
'Playing cycling'	7.0	5.3	13.5	10.8	1.9	6.7
'Playing BMX'	7.0	6.0	16.1	8.1	6.4	7.5
In pram	3.5	2.6	1.9	8.5	9.0	3.8
Other	9.5	29.6	10.3	8.5	6.7	18.2
Base	803	1287	310	223	267	2890

As was the case in both of the other surveys it can be seen that there were some appreciable differences in the proportions of children observed on each of the sections. However, as previously noted, the differences between sections cannot be compared between this survey and the Nelson surveys.

It can be seen that a higher proportion of children were observed playing on Sections 1 and 5 than on the other 3 sections. Also a higher proportion of children were observed cycling (using both BMX and other types of bicycles), particularly 'playing cycling' on Section 3 than on the other sections. Finally, it is also apparent from the table that a large proportion of the children on Section 2 compared to the other sections were described as involved in 'other' activities. This is because this section passes through the Arneside shopping centre. This was the only point of the routes in either study area, where at certain times of the day, the number of children observed in one place became so large that it was not possible to accurately record all their details. Thus, it was not possible to say how many of these children were playing at the shops, or were on errands there. For this reason, all of the children seen at this location at busy shopping periods were put into the 'other' category of activity. This problem has not affected any of the other analyses, as it was still possible to record the age, sex and accompaniment characteristics of the observed children.

Of the children observed on main roads, 18.8% were playing, while of those observed on other roads, 39.8% were playing. The proportion of children observed playing on main roads in this survey is similar to that in the Nelson school holiday survey, but the proportion of children observed on other roads playing was appreciably smaller in this survey. A greater proportion of the children observed on main roads were walking/on errands (37.0%) than the children observed on other roads (19.6%). Here the pattern is the same as in the Nelson school holiday survey, though the magnitude of the difference is smaller. As in the Nelson school holiday survey, a larger proportion of children observed on main roads were cycling, and in the case of this study, cycling with a BMX (6.9% and 2.9% respectively), than the proportion of children observed on other roads (1.6% and 1.1%). Of the children observed on main roads, a smaller proportion were 'playing cycling' and 'playing with BMX' (4.8% and 3.4% respectively) than the proportion of children observed on other roads undertaking these activities (7.3% and 8.7% respectively).

Time of day

Table 8.25 shows the same activities as in Table 8.24 by the period of the day in which they were observed.

Table 8.25: Activity of the children observed by the period of the day in the Bristol school holiday survey (all figures except the base are percentages).

Activity	Period 1	2	3	4	5	Total
Walking/ errand	30.2	29.7	25.8	22.1	15.5	24.2
Playing	21.0	23.8	35.3	39.2	51.1	35.4
Cycling	1.8	3.6	3.6	2.4	1.7	2.7
BMX	1.8	1.5	1.2	2.2	1.1	1.5
'Playing cycling'	5.0	6.1	7.3	5.9	8.3	6.7
'Playing BMX'	6.2	5.7	3.3	10.9	11.9	7.5
In pram	7.7	4.0	3.9	3.1	2.2	3.8
Other	26.3	25.6	19.6	14.2	8.2	18.2
Base	338	668	694	543	647	2890

This shows that there were differences in the timing of the various activities throughout the day. As was the case in the Nelson school holiday survey, the proportion of children observed in Period 1 who were playing was the lowest of the 5 periods, and the proportion in Period 5 the highest. The table also shows that as in the Nelson school holiday survey, children who go out early in the day are more likely to be going out walking or on an errand, than those who go out later. However, the proportion of children observed in Period 1 in this survey who were walking/on errands is appreciably lower than that in the Nelson school holiday survey. Part of the reason for this difference could be the higher proportion of children cycling in Period 1 in the Bristol survey compared to the Nelson survey (14.8% compared to 4.0%). In the Bristol survey there were a higher proportion of children observed cycling in Periods 4 and 5 than in the other 3 periods, while in the Nelson school holiday survey there were a higher proportion of children observed cycling in Period 3 than at any other surveyed time. As in the Nelson survey more children in prams were seen in the morning than later in the day, but the proportions observed in prams in the final three periods of the day in Bristol were not nearly so small as in Nelson.

8.4.4 Summary. A number of important differences in the types of use that different groups of children make of the roads at various locations and times have been identified firstly between schooldays and school holidays in the Nelson study area, and secondly between the Bristol and Nelson areas on school holidays. These are summarised here.

Schooldays and school holidays in Nelson

In the schoolday survey a larger proportion of children were observed playing and a smaller proportion walking/on errands than in the school holiday survey. In both surveys a greater proportion of girls than boys were observed walking/on errands, though in the school holiday survey the difference between the sexes is greater than in the schoolday survey. In both surveys the proportions of pre-school children observed playing were about equal, while in the schoolday survey the proportions of school age children observed playing was substantially higher than in the holiday survey. The patterns of use of each of the different sections and different types of road were very similar between the two surveys. Throughout the surveyed period a higher proportion of children were observed playing in the schoolday survey compared to the holiday survey, except in Period 3. In the school holiday survey during Period 3 only a very small proportion of children were observed in prams, while in the schoolday survey about 17% of the children observed were in prams. In the schoolday survey virtually no children were observed cycling in the first three periods of the day, while in the school holiday survey the highest proportion of children observed cycling was during Period 3.

Nelson and Bristol in the school holidays

There are a number of important differences in activity patterns between the Nelson and Bristol school holiday surveys. Firstly there was an appreciably smaller proportion of children observed playing (on foot only) in the Bristol survey compared to the Nelson survey. Some of this difference can be explained by the greater proportion of children in the Bristol area who were observed 'playing cycling' (including both BMX and other types of bicycle). In the Bristol area children either have greater access to bicycles than children in the Nelson area, or they choose to use them more. Of those children observed cycling in the two areas, a greater proportion were boys in the Nelson area than in the Bristol area. The proportions of pre-school and primary school age children observed playing (on foot) on the roads were much smaller in the Bristol survey than in the Nelson survey. This might indicate a difference in the way that parents or children perceive roads and road safety in the two areas, or a better provision of alternative play spaces in the Bristol area compared to

Nelson. The proportion of children observed on main roads who were playing was about the same in both surveys, however the proportion of children observed on other roads who were playing was substantially lower in the Bristol survey compared to the Nelson survey. Finally, in terms of time, the proportion of children observed in Period 1 in the Bristol survey who were walking/on errands is appreciably lower than that in the Nelson survey. Also the timing of the peak cycling periods differs between the surveys. In the Nelson survey in Period 3 a higher proportion of children were observed cycling than in other periods, while in the Bristol survey Periods 4 and 5 contained the highest proportions of children observed cycling.

8.5 Accompaniment

As explained in Chapter 7 there were three types of accompaniment recorded in these surveys. These are accompaniment by an adult, accompaniment by an older child, and accompaniment by a contemporary or younger child. These were chosen with their safety connotations in mind, as it was thought that a degree of extra protection (in terms of road safety) may be given if a child is accompanied by an adult, and in some circumstances by an older child, though perhaps not if accompanied by a contemporary or younger child. The system of recording accompaniment in the following tables is hierarchical. Children classified as being accompanied by adults, may either have been with one or more adults alone, or in a mixed group of adults and children of any age. The accompaniment of children by other children of any age is not recorded in the table when an adult is also present because in terms of road safety, the most important members of the group are considered to be the adults. The category 'older children' describes accompaniment by older children where no adults were present, though younger children could also be present. Finally, the category 'contemporaries/younger children' describes a situation where only children of the same age or younger were present. For example, if a group of three children, one of pre-school age, one of primary school age and one of secondary school age were observed together, then both of the younger children would appear in the 'older children' accompaniment category, while the secondary school age child would appear in the 'contemporaries/younger children' accompaniment category. If there was also an adult present then all three children would appear in the 'adults' accompaniment category.

8.5.1 The Nelson schoolday survey. Table 8.26 shows the levels of accompaniment for various groups of children observed in the Nelson schoolday survey.

This shows that just under a quarter of the children were observed while accompanied by at least one adult. This proportion varies both with age and sex. A larger proportion of girls than boys were observed while in the company of an adult (28.5% and 19.6% respectively). Also a much greater proportion of pre-school children were accompanied by adults (50.8%) than primary (11.1%) and secondary school children (3.6%). A greater proportion of secondary school girls than boys were accompanied by adults (7.8% and 2.0% respectively), whereas the proportions of younger boys and girls accompanied by adults were about equal.

Table 8.26: Age and sex of the children observed by their accompaniment in the Nelson schoolday survey (all figures except the base are percentages).

	Age and sex											
	Pre-school			Primary			Secondary			All ages		
	B*	G	All	B	G	All	B	G	All	B	G	All
Adults	50.2	51.5	50.8	10.8	11.6	11.1	2.0	7.8	3.6	19.6	28.5	23.1
Older children	9.1	10.6	9.8	8.1	6.7	7.6	-	-	-	5.8	7.2	6.3
Contemps./ younger children	33.6	31.3	32.5	66.8	71.8	68.7	76.3	75.7	76.1	60.1	54.7	58.0
Alone	7.1	6.6	6.9	14.3	9.9	12.6	21.7	16.5	20.3	14.5	9.6	12.6
Base	574	549	1123	753	465	1218	614	230	844	1941	1244	3185

* B = Boys, G = Girls

Only 6.3% of the observed children were accompanied by at least one older child. A slightly greater proportion of girls were accompanied by older children than boys (7.2% and 5.8% respectively).

More than half of the children observed were accompanied by contemporaries or younger children. A larger proportion of boys than girls were accompanied by contemporaries or younger children. The proportion of school age children observed accompanied by contemporaries or younger children was substantially greater than the proportion of pre-school children.

About one in eight of the observed children were alone. A greater proportion of boys than girls and a greater proportion of secondary school children than primary school or pre-school children were observed alone.

In general, these figures give the impression that girls, and younger children were more protected (if accompaniment by older people can be considered to be protection in road safety terms), than boys, especially older boys. It would also seem that primary and secondary school age children use the roads more with contemporaries or younger children than pre-school children, and thus to a certain extent could be considered to be more at risk.

8.5.2 The Nelson school holiday survey. Table 8.27 shows the levels of accompaniment for children observed in the Nelson school holiday survey.

Table 8.27: Age and sex of the children observed by their accompaniment in the Nelson school holiday survey (all figures except the base are percentages).

	Age and sex											
	Pre-school			Primary			Secondary			All ages		
	B*	G	All	B	G	All	B	G	All	B	G	All
Adults	36.8	36.6	36.7	14.5	17.5	15.6	1.7	6.7	3.4	16.1	21.6	18.2
Older children	17.8	15.2	16.5	3.6	3.5	3.6	-	-	-	5.6	6.6	6.0
Contemps./ younger children	33.3	39.8	36.5	67.0	71.9	68.6	73.6	71.6	72.9	61.7	61.5	61.6
Alone	12.1	8.4	10.3	14.9	7.1	12.2	24.7	21.7	23.7	16.6	10.3	14.2
Base	568	558	1126	1577	858	2435	652	327	979	2797	1743	4540

* B = Boys, G = Girls

A smaller proportion of the children observed in this survey were accompanied by adults than in the Nelson schoolday survey. This is not only because a greater proportion of the children observed in the schoolday survey were of pre-school age than in the holiday survey but also because, as discussed further below, more of these children were accompanied by adults in the schoolday survey. As in the Nelson schoolday survey a smaller proportion of boys were observed while in the company of adults (16.1%) than girls (21.6%). Also a similar proportion of children of secondary school age were accompanied by one or more adults in this survey and in the Nelson schoolday survey. However, a very much smaller proportion of pre-school children were observed accompanied by an adult in this survey compared to the Nelson schoolday survey. This might be because on school holidays parents are more willing to let their young children out on the streets unaccompanied as there are more children using the streets than on schooldays when school age children are at school. On schooldays when there are less children on the streets during the day parents might consider it less safe to let their young children out unless they can accompany them. Also in the school holiday survey there were a larger proportion of primary school children accompanied by adults than in the schoolday survey. Finally, in both surveys a substantially greater proportion of secondary school girls than boys were accompanied by adults, while the proportions of younger boys and girls accompanied by adults were more equal.

The overall proportion of children accompanied by older children is about the same as that observed in the schoolday survey, but this proportion is higher among the pre-school children and lower among the primary school children than in the schoolday survey. The proportions of boys and girls observed accompanied by older children are about the same in both surveys.

A slightly larger proportion of children were observed accompanied by contemporaries/younger children in this survey than in the Nelson schoolday survey. Also in this survey about equal proportions of boys and girls were accompanied by contemporaries or younger children, whereas in the schoolday survey a larger proportion of boys were accompanied by contemporaries or younger children than girls. In both surveys the proportion of school age children who were accompanied by contemporaries or younger children was substantially greater than the proportions of pre-school children accompanied by contemporaries or younger children.

Finally, as in the Nelson schoolday survey a larger proportion of boys than girls were observed alone and a larger proportion of secondary school children were observed alone compared to primary and pre-school children.

8.5.3 The Bristol school holiday survey. Table 8.28 shows the levels of accompaniment for various groups of children observed in the Bristol school holiday survey.

Table 8.28: Age and sex of the children observed by their accompaniment in the Bristol school holiday survey (all figures except the base are percentages).

	Age and sex											
	Pre-school			Primary			Secondary			All ages		
	B*	G	All	B	G	All	B	G	All	B	G	All
Adults	52.4	50.7	51.6	16.5	25.7	20.5	4.3	14.6	8.3	19.5	28.4	23.3
Older children	18.8	18.0	18.4	7.6	9.4	8.4	-	-	-	7.2	8.7	7.8
Contemps./ younger children	8.6	11.0	9.7	51.2	47.9	49.8	66.0	62.2	64.5	47.7	43.2	45.9
Alone	20.2	20.3	20.3	24.7	17.0	21.3	29.7	23.2	27.2	25.6	19.7	23.0
Base	336	300	636	733	565	1298	586	370	956	1655	1235	2890

* B = Boys, G = Girls

In this survey a larger proportion of children were observed in the company of at least one adult than in the Nelson school holiday survey. As in the Nelson holiday survey a greater proportion of girls were observed accompanied by one or more adults than boys. Also in both surveys a greater proportion of pre-school children were accompanied by adults than primary or secondary school children. As was the case in the Nelson school holiday survey, about equal proportions of pre-school boys and girls and a larger proportion of secondary school girls than boys were observed accompanied by adults. However, in the Bristol survey the proportion of primary school girls observed accompanied by an adult is much greater than the proportion of primary school boys, whereas in the Nelson holiday survey the differences in the proportions of primary school boys and girls observed accompanied by adults was not as large. This means that primary school girls and boys are treated differently, in terms of the amount of adult accompaniment they receive, between the two study areas.

A slightly higher proportion of children in the Bristol survey were accompanied by older children than in the Nelson school holiday survey, though in both cases the proportion of girls accompanied by older children was higher than the proportion of boys.

An appreciably smaller proportion of children were observed accompanied by a contemporary or younger child than in the Nelson school holiday survey. This might be related to the fact that a smaller proportion of children in the Bristol school holiday survey were observed playing than in the Nelson school holiday survey (see Tables 8.20 and 8.23). A slightly greater proportion of boys than girls were accompanied by contemporaries or younger children. This differs from the Nelson survey where the proportions of boys and girls accompanied by contemporaries/younger children were the same.

The proportion of children observed alone in this survey was substantially greater than in the Nelson survey, though in both surveys a larger proportion of boys than girls were observed alone. Also in both surveys a greater proportion of secondary school children than primary or pre-school children were observed alone. However, the differences in the proportions of children observed alone in each of the three age groups are very much smaller in the Bristol survey, than in the Nelson survey where the proportion of secondary school children observed alone was substantially larger than the proportion of pre-school or primary school children. In the Bristol survey the proportions of pre-school and primary school children observed alone are about double the proportions observed in the Nelson survey.

8.5.4 Summary. A number of important differences in the patterns of accompaniment of different groups of children have been identified, firstly between schooldays and school holidays in the Nelson study area, and secondly between the Bristol and Nelson areas in school holidays. These are summarised here.

Schooldays and school holidays in Nelson

A slightly lower proportion of children were accompanied by adults in the school holiday survey than in the schoolday survey. Most of this difference is accounted for by there being a lower proportion of pre-school children accompanied by adults in the holiday survey than in the schoolday survey. This might be because on holidays there are more likely to be other children playing on the streets and so the streets are perceived as being relatively safer (perhaps not just from a road safety point of view) by parents, whereas during the day on schooldays when there are very few other (in particular older) children around this may not be the case. Also in the schoolday survey there were a larger proportion of boys accompanied by contemporaries or younger children than girls, whereas in the school holiday survey the proportions were about the same. These findings indicate a greater degree of protection given to children on schooldays compared to holidays, which is consistent with the larger proportion of pre-school children observed on schooldays compared to holidays. These findings also indicate that on schooldays during school hours parents (or other adults) accompany their children more than on school holidays.

Nelson and Bristol in the school holidays

In the Bristol survey a larger proportion of children were observed accompanied by adults than in the Nelson survey. In both surveys the proportion of primary school girls accompanied by adults is greater than the proportion of primary school boys accompanied by adults, though in the Nelson survey the difference between the two is not as large as in the Bristol survey. A very much smaller proportion of children were observed accompanied by contemporaries or younger children in the Bristol survey compared to the Nelson survey. However, the proportion of children observed alone in the Bristol survey was substantially greater than in the Nelson survey. This was particularly the case for pre-school and primary school children. These findings seem to indicate that children in the Nelson study area are less protected than children in the Bristol study area. Overall in the Nelson survey a greater proportion of children were observed unaccompanied by older people (i.e alone or with contemporaries or younger people) than in the Bristol survey.

8.6 Accompaniment and activity

8.6.1 The Nelson schoolday survey.

Table 8.29 shows the accompaniment levels associated with various types of activity.

Table 8.29: Levels of accompaniment by activity in the Nelson schoolday survey (all figures except the base are percentages).

Activity	Accompaniment by				Base
	Adults	Older children	Contemporaries/ younger children	Alone	
Walking/ errand	45.6	5.9	31.6	16.9	658
Playing	10.6	7.5	74.0	7.9	1893
Cycling	4.9	1.6	19.8	73.7	61
'Playing cycling'	3.5	3.0	70.9	22.6	230
In pram	98.2	1.8	0.0	0.0	168
Other	34.3	5.7	34.3	25.7	175
Total	23.1	6.3	58.0	12.6	3185

The table shows that certain types of activity were associated with particular patterns of accompaniment by different groups of people. It can be seen that only about one in ten children observed playing were accompanied by adults. This indicates either that adults do not want to join in children's street play very often, or perhaps that children object to their presence. On the other hand, nearly half of the children observed walking/on errands were accompanied by adults. Often children accompany adults to shops or on other errand type journeys because they are needed (for instance to help with carrying) or in some cases because they are considered too young to remain at home alone. The proportions of children observed playing on foot and on bicycles who were accompanied by contemporaries or younger children is very much higher than for any other category of activity. Finally, a very high proportion of children observed cycling (not playing) were alone.

8.6.2 The Nelson school holiday survey. Table 8.30 shows the accompaniment levels associated with various types of activity.

Table 8.30: Levels of accompaniment by activity in the Nelson school holiday survey (all figures except the base are percentages).

Activity	Accompaniment by				Base
	Adults	Older children	Contemporaries/ younger children	Alone	
Walking/ errand	41.3	4.5	38.4	15.8	1212
Playing	6.0	8.5	77.7	7.8	2283
Cycling	1.2	0.6	47.4	50.8	171
'Playing cycling'	0.8	2.3	80.3	16.6	259
In pram	93.0	2.8	1.4	2.8	72
Other	21.2	2.8	49.8	26.2	543
Total	18.2	6.0	61.6	14.2	4540

It can be seen that as in the Nelson schoolday survey a much lower proportion of children observed playing were accompanied by adults than children observed walking/on errands, and a much higher proportion of children observed playing were accompanied by contemporaries/younger children than children observed walking/on errands. Also in both surveys the proportions of children observed walking/on errands who were alone were very similar, being in both cases about double the proportions of children observed playing who were alone. In the Nelson school holiday survey about half of the children observed cycling were alone, compared to about three-quarters in the Nelson schoolday survey. Finally in both surveys nearly all of the children observed in prams were accompanied by adults.

8.6.3 The Bristol school holiday survey. Table 8.31 shows the levels of accompaniment associated with various types of activity.

Table 8.31: Levels of accompaniment by activity in the Bristol school holiday survey (all figures except the base are percentages).

Activity	Accompaniment by				Base
	Adults	Older children	Contemporaries/ younger children	Alone	
Walking/ errand	50.1	4.3	33.3	12.3	699
Playing	7.4	15.0	67.7	9.9	1019
Cycling	19.0	0.0	8.9	72.1	79
BMX	4.8	2.4	14.3	78.5	42
'Playing cycling'	0.5	4.1	71.8	23.6	195
'Playing BMX'	0.9	5.0	73.5	20.6	218
In pram	93.7	6.3	0.0	0.0	111
Other	23.5	3.0	16.9	56.6	527
Total	23.3	7.8	45.9	23.0	2890

It can be seen that the general patterns of accompaniment by type of activity in this survey are similar to that of the Nelson school holiday survey. However, there are a few differences between them. Firstly, the proportion of children walking/on errands who were accompanied by adults is appreciably higher in the Bristol survey than in the Nelson school holiday survey, while the proportion of children walking/on errands who were accompanied by contemporaries/younger children was lower in the Bristol survey than in the Nelson school holiday survey. The table shows that the proportion of children observed playing who were accompanied by contemporaries or younger children is higher in the Nelson school holiday survey than in the Bristol survey. Finally, in the Bristol survey the proportion of children observed cycling (not for play purposes) who were alone was substantially higher than in the Nelson survey.

8.7 Exposure and risk

In order to assess the risk of various groups of children in the study areas, at particular times and locations, it was decided to use a measure called 'relative risk' or 'relative hazard' (see Jonah and Engel,1983, or Knoblauch et al,1984). This relates the occurrence of certain factors in the accident population to their occurrence in the general population at risk (in this case the observed population). "These hazard scores are the ratio created by dividing the percentage of occurrence of a characteristic in either the accident population or the exposure population by the percentage of occurrence in the other population. In order to maintain an interval scale, the larger percentage is always divided by the smaller percentage. Thus, hazard scores always have an absolute value greater than or equal to 1.0. If the accident population had the larger percentage - an indication that more hazard is associated with the characteristic - the hazard score is presented as a positive number. If the exposure population had the larger percentage, the hazard score is presented as a negative number - an indication that less hazard is associated with the characteristic" (Knoblauch et al,1984,p38). If exposure completely explains any differences in the proportions of accidents then the Relative Risk (RR) values will be 1. The greater the range of RR values of the different levels of each variable (e.g boys and girls, or pre-school, primary school, and secondary school children), then the poorer is the degree of explanation of the pattern of accidents by exposure, while there is an increased likelihood that some other factor, such as behaviour, is the cause of any variation in the accident patterns.

As much as possible in these analyses, the accident populations will refer to the same situations as the exposure populations. However, due to the limited number of accidents available, certain liberties have had to be taken with the total population of accidents.

For the two school holiday surveys, the accident population contains all accidents which occurred on the MOBs routes and in the SOBs data collection areas on both weekdays and weekends in the school holidays throughout each whole day and over each whole year. It was considered justifiable to include accidents on holiday weekends, as it has already been shown in a previous study (Knighting et al,1972 - see Chapter 7), that accident patterns are very similar in a number of respects between weekdays and weekends in the school holidays. Also in the present study it has been shown (see Table 3.10) that in the

Bristol and Nelson study areas the average number of accidents per day on holiday weekdays is similar to the average number of accidents on holiday weekends. A breakdown of accidents for these two periods by time of day (see Table 7.2) shows that they are not inconsistent with a broadly similar distribution of accidents over the two kinds of day. Although the exposure surveys only covered 5 one and a half hour periods of the day, accidents have been included throughout the whole day. This is because, if only accidents which occurred during survey times are included, then the accident population becomes too small to use (i.e 2 or 3 accidents in Bristol). However, most of the accidents occur either during the survey times, or within them (i.e between 12.15pm and 2.00pm or 3.30pm and 4.45pm), so that it is thought reasonable to assume that in the case of school holidays the exposure population will still be representative of the type of conditions that were present at the time of the accidents. This will mean a restriction on analyses by period or time of day, but this is a small problem compared to the advantages of having a larger accident population. These limitations on the analysis of accident risk are severe and could only be overcome by extending the scale of the work, but the study nevertheless serves to demonstrate the feasibility and effectiveness of this method of data collection. In a full scale study, in order to obtain a larger accident population, it would be necessary either to collect data over a larger area, or to have collected accident information over a longer period of time, although, in this latter case, care would have to be taken to ensure that neither the areas used nor the patterns of children's use of those areas had changed significantly over the period of data collection.

For the Nelson schoolday survey, it was found that there were a larger number of accidents on relevant days, and thus it was not considered necessary to include accidents on weekends in term time (nor was it known that these have similar characteristics to weekday accidents). For this survey only accidents which did not occur on journeys to and from school were included. Also, unlike in the case of the school holiday surveys, it is not considered possible to include accidents which occurred throughout the whole of each schoolday, but rather only those which occurred within the five survey periods. This is because on schooldays exposure in the observed periods cannot be representative of exposure in the midday and late afternoon periods.

Values of RR were calculated for each survey, for each of the different age and sex groups of children, and for different locations and times of day. More detailed analyses (e.g to find the RR value of male pre-school children outside shops) were not possible due to insufficient accidents making the results of such analyses statistically meaningless. It was also not possible to examine the RR values for various types of activity and various levels of accompaniment, as these variables are not recorded in sufficient detail on either the 'Stats 19' form, or in the more detailed police accident records. Where possible and relevant, mention will be made of the likely effects that these two factors could have upon the RR values obtained.

For the purposes of these analyses, children observed using a bicycle, including a BMX type bicycle in Bristol, have been left out, because the accident data set only includes child pedestrians.

8.7.1 The Nelson schoolday survey. Table 8.32 shows the RR values calculated for certain types of child, location and time in the Nelson schoolday survey.

Table 8.32: Relative risk for some variables from the Nelson schoolday survey.

Variable	Percentage of		Relative risk
	Accidents (base=40)	Observed children (base=2894)	
Sex:			
Boys	60.0	58.0	+1.03
Girls	40.0	42.0	-1.05
Age:			
Pre-school	22.5	38.2	-1.70
Primary school	67.5	37.6	+1.80
Secondary school	10.0	24.2	-2.42
Age and sex:			
Pre-school boys	12.5	19.4	-1.55
girls	10.0	18.8	-1.88
Primary boys	42.5	21.8	+1.95
girls	25.0	15.8	+1.58
Secondary boys	5.0	16.7	-3.34
girls	5.0	7.5	-1.50
Location:			
Section 1	45.0	34.3	+1.31
2	20.0	15.8	+1.27
3	7.5	17.2	-2.29
4	20.0	25.9	-1.30
5	7.5	6.8	+1.10
Road type:			
Main	67.5	29.9	+2.26
Other	32.5	70.1	-2.16
Time of day:			
Morning*	20.0	14.8	+1.35
Afternoon	80.0	85.2	-1.07

* - Before 1pm.

This table shows firstly that boys and girls have very similar levels of RR. That is, although boys were involved in a larger proportion of accidents than girls, they also accounted for a correspondingly higher proportion of exposure. Thus in this example the amounts of exposure accounted for by boys and girls appears to explain the numbers of accidents very well.

In terms of age, it can be seen that children of secondary school age were the least at risk of the three age groups with an RR value of -2.42. If it is assumed that the 40 accidents in the sample are binomially distributed between any two groups of children being compared and that the sampling error in the exposure measures is small compared to the sampling error in the accident measures, it is then possible to test the significance of the difference between the observed value of RR and unity. The null hypothesis would be that the expected proportion of accidents to secondary school children is the same as the proportion of exposure accounted for by secondary school children (i.e that the expected value of RR is 1). The probability that out of a total of n accidents, x occur to secondary school children, given their expected proportion π of accidents, is given by Equation 8.1.

$$P = \frac{n!}{x!\,(n-x)!}.\pi^{x}\,(1-\pi)^{n-x} \qquad 8.1$$

Calculation of the sum of the probabilities for x = 4, 3, 2, 1 and 0 shows that the probability of obtaining a value of 4 accidents or less to secondary school children, given the expected distribution of accidents between the age groups, is 0.021. Thus (because the probability distribution has two tails) the probability of obtaining a number of accidents to secondary school children which is at least as extreme as 4 accidents is from the expected number of accidents is 0.042. The 95% confidence intervals of the observed value of RR for secondary school children are -48.4 and -1.24. These figures show that the difference between the observed value of RR for secondary school children and unity is unlikely to have arisen by chance. Using the same method it can also be shown that the difference between the observed value of RR for pre-school children and unity is unlikely to have arisen by chance ($p=0.054$). Finally, for primary school children it can be shown that the difference between the observed value of RR and unity is very unlikely to have arisen by chance ($p=0.002$). The 95% confidence intervals of the observed value of RR for primary school children are +1.40 and +2.19. The RR values for age show that, allowing for the amount of use made of the roads, primary school children have a much higher risk of being involved in a road accident than other age groups of children, especially secondary school children. This is possibly because secondary school children are more experienced and are thus better able to cope with the road system than primary school children. The reason that the RR value for pre-school children is also negative is probably related to the fact that about half of the pre-school children observed on schooldays were accompanied by adults compared to only about one in ten of the primary school children observed (see Table 8.26).

The next section of Table 8.32 examines the pattern of RR between different age and sex groups. It can be seen that the value of RR for secondary school boys is particularly low. Again using the methods described above and Equation 8.1 it is possible to show that the difference between the observed value of RR for secondary school boys and unity is unlikely to have arisen by chance ($p=0.054$). In the same way it can be shown that the differences between the observed RR values for each of the other age and sex groups and unity could easily have arisen by chance.

In terms of location Section 3 has the lowest value of RR. It can be shown that the difference between the observed value of RR for Section 3 and unity is not very likely to have arisen by chance ($p=0.140$). If this difference was confirmed as being real in a larger study it is likely that part of the reason for the low value of RR of Section 3 compared to the other sections is that there are only very small lengths of main road either along the section itself or in the surrounding SOBs data collection areas. For each of the other 4 sections the differences between the observed values of RR and unity could easily have arisen by chance.

In terms of road type, the RR value for main roads is very much higher than that for other roads. It can be shown that the differences between the observed values of RR for both main and other roads and unity are very unlikely to have arisen by chance ($p<0.001$). The 95% confidence intervals of the observed value of RR for main roads are +1.76 and +2.75. The most likely reasons for the high RR value on main roads compared to other roads is that in general main roads have greater amounts of traffic than other roads and are consequently more difficult and dangerous to cross.

Finally, it can be seen from the table that the RR value in the morning is greater than in the afternoon. However, it can be shown using the above method, that the differences between the observed values of RR for both the morning and afternoon periods and unity could easily have arisen by chance.

Table 8.33 shows the RR values for child pedestrians in different types of traffic environment for the Nelson schoolday survey. For the purposes of this table, only children who were observed on the MOBs route and accidents which occurred on the MOBs route are included. This is because no information on traffic flow was collected for the SOBs data collection areas. In this table the term 'traffic environment' refers to the average (over the whole week) number of vehicles per hour which passed the enumerator in both directions, for each of the 15 traffic count sections shown in Figures 7.8 to 7.12.

Table 8.33: Relative risk for child pedestrians in different types of traffic environment in the Nelson schoolday survey.

Variable	Percentage of		Relative risk
	Accidents (base=23)	Observed children (base=1328)	
Traffic environment (vehicles/h):			
<201	13.0	36.2	-2.78
201-500	69.6	56.1	+1.24
>500	17.4	7.7	+2.26

The table shows that the RR value for roads with an average traffic flow of less than 201 vehicles/h is less than the RR values for roads with higher average traffic flows. Making the same assumptions as in the previous examples it can be shown that the difference between the observed value of RR for roads with an average hourly traffic flow of less than 201 vehicles and unity is unlikely to have arisen by chance (p=0.026). The upper 95% confidence interval of the observed value of RR for roads with an average hourly flow of less than 201 vehicles is -1.34. These findings back up the results described above for type of road and indicate that children stand a smaller chance of being involved in a road accident on roads where the traffic flow is low than on roads (not necessarily main roads) where the traffic flow is relatively high.

8.7.2 The Nelson school holiday survey. Table 8.34 shows the RR values calculated for certain types of child, location and time in the Nelson school holiday survey.

This table shows that the RR value for boys is higher than that for girls. It can be shown that the differences between the observed RR values for both boys and girls and unity are not very likely to have arisen by chance (p=0.108). If these differences were confirmed in a larger study then they would show that the patterns of RR to boys and girls differ between schooldays and holidays in Nelson.

In terms of age it can be seen from the table that the value of RR for pre-school children is higher than that for school age children. However, it can be shown that the differences between the RR values for both pre-school and school age children and unity could easily have arisen by chance (p>0.40). This pattern differs from the schoolday survey where it was shown that primary school children had a higher RR value than either pre-school or secondary school children. This might be partly because of the fact that in the Nelson schoolday survey the proportion of pre-school children accompanied by adults was very much higher than was the case in the Nelson school holiday survey (see Tables 8.26 and 8.27).

Table 8.34: Relative risk for some variables from the Nelson school holiday survey.

Variable		Percentage of		Relative risk
		Accidents (base=25)	Observed children (base=4110)	
Sex:				
Boys		76.0	58.5	+1.30
Girls		24.0	41.5	-1.73
Age:				
Pre-school		36.0	26.7	+1.35
School age		64.0	73.3	-1.15
Age and sex:				
Pre-school	boys	24.0	13.3	+1.80
	girls	12.0	13.4	-1.12
Primary	boys	44.0	32.1	+1.37
	girls	4.0	20.5	-5.13
Secondary	boys	8.0	13.1	-1.64
	girls	8.0	7.6	+1.05
Location:				
Section	1	36.0	31.6	+1.14
	2	12.0	14.5	-1.21
	3	4.0	16.5	-4.13
	4	44.0	30.2	+1.46
	5	4.0	7.2	-1.80
Road type:				
Main		60.0	28.3	+2.12
Other		40.0	71.7	-1.79
Time of day:				
Morning*		24.0	27.8	-1.16
Afternoon		76.0	72.2	+1.05

* - Before 1pm.

Table 8.34 shows that the lowest RR value is for primary school girls indicating that this group of children have a relatively low likelihood of being involved in a road accident. It can be shown that the difference between the observed RR value for primary school girls and unity is unlikely to have arisen by chance (p=0.048). The upper 95% confidence interval of the observed value of RR for primary school girls is -1.74. It can be shown that the differences between the RR values for each of the other age and sex groups and unity could easily have arisen by chance. This pattern differs from the Nelson schoolday survey where it was shown that secondary school boys had a lower RR value than any of the other age and sex groups.

In terms of location it can be seen that the lowest value of RR is for Section 3. The difference between this value and unity is not very likely to have arisen by chance (p=0.13). This finding is the same as that in the Nelson schoolday survey, which adds weight to the likelihood that the differences are in fact real in both cases. The reason for the low RR value on Section 3 in this survey is likely to be the same as that described in the schoolday survey. As was the case in the schoolday survey the differences between the observed values of RR for each of the other sections and unity could easily have arisen by chance.

As was the case in the Nelson schoolday survey there is a much higher risk of an accident on main roads compared to other roads. The differences between the observed RR values for both main and other roads and unity are very unlikely to have arisen by chance (p=0.002). The 95% confidence intervals of the observed value of RR for main roads are +1.43 and +2.81. These values coincide to a large degree with the 95% confidence intervals of the observed RR value for main roads for the schoolday survey. This indicates that the amount of extra risk encountered by children when using main roads compared to other roads is very consistent between the two types of time period in Nelson. This type of result strongly suggests that measures should be taken either to make main roads safer for children to use, or to reduce children's need to use them.

Finally, the table shows, as was the case in the schoolday survey, that the differences between the RR values for both the morning and afternoon periods and unity could easily have arisen by chance.

Table 8.35 shows the RR values for child pedestrians in different types of traffic environment. In this table the term 'traffic environment' again refers to the average (over the whole week) number of vehicles per hour which passed the enumerator in both directions, for each of the 15 traffic count sections shown in Figures 7.8 to 7.12.

Table 8.35: Relative risk for child pedestrians in different types of traffic environment in the Nelson school holiday survey.

Variable	Percentage of		Relative risk
	Accidents (base=18)	Observed children (base=1799)	
Traffic environment (vehicles/h)			
<201	5.6	40.4	-7.21
201-500	88.8	46.5	+1.91
>500	5.6	13.1	-2.34

The table shows that the RR value for roads with an average traffic flow of less than 201 vehicles/h is much less than the RR values for roads with a higher traffic flow. It can be shown that the difference between the observed RR values for roads with an average hourly traffic flow of less than 201 vehicles and unity is very unlikely to have arisen by chance (p=0.002). The upper 95% confidence interval for roads with an average hourly traffic flow of less than 201 vehicles is -2.46. This relative safety of roads with low traffic flow is consistent with the conclusion from the Nelson schoolday survey. Finally Table 8.35 shows that at very high average traffic flows (>500 vehicles/h) the observed RR value is negative, indicating a low risk. However, it can be shown that the difference between the observed RR value for roads with a high traffic flow and unity could easily have arisen by chance.

8.7.3 The Bristol school holiday survey. Table 8.36 shows the RR values calculated for certain types of children, locations, and times in the Bristol school holiday survey.

Table 8.36: Relative risk for some variables from the Bristol school holiday survey.

Variable	Percentage of		Relative risk
	Accidents (base=10)	Observed children (base=2355)	
Sex:			
Boys	90.0	51.6	+1.74
Girls	10.0	48.4	-4.84
Age:			
Pre-school	20.0	25.9	-1.30
Primary school	60.0	43.6	+1.38
Secondary school	20.0	30.5	-1.53
Age and sex:			
Pre-school boys	20.0	13.2	+1.52
girls	0.0	12.6	
Primary boys	60.0	21.7	+2.76
girls	0.0	22.0	
Secondary boys	10.0	16.7	-1.67
girls	10.0	13.8	-1.38
Location:			
Section 1	50.0	27.7	+1.81
2	40.0	47.0	-1.18
3	0.0	8.8	
4	0.0	6.9	
5	10.0	9.6	+1.04
Road type:			
Main	50.0	21.7	+2.30
Other	50.0	78.3	-1.57
Time of day:			
Morning*	10.0	35.8	-3.58
Afternoon	90.0	64.2	+1.40

* - Before 1pm.

It can be seen that in this survey the sample of accidents is very small (10 accidents) compared to the other two surveys. This means that unless the differences between the observed RR values and unity are relatively large compared to the other surveys it will not be possible to distinguish them from chance fluctuations.

The table shows that the RR value for boys is greater than that for girls. It can be shown that the differences between the observed RR values for both boys and girls and unity are unlikely to have arisen by chance (p=0.028). The lower 95% confidence interval of the observed value of RR for boys is +1.38. It was also shown in the Nelson school holiday survey that boys have a higher RR value than girls, though the likelihood of the result being due to chance was higher in that survey than in the Bristol survey. In both of the surveys boys account for a slightly greater proportion of the exposure, but a much greater proportion of the accidents. These findings indicate a need for a more detailed study of children's behaviour in given traffic situations to try to identify why boys are involved in a greater number of road accidents than girls.

In terms of age it can be shown, as in the Nelson school holiday survey, that the differences between the observed values of RR for each age group and unity could easily have arisen by chance.

If the breakdown by age and sex is considered it can be seen that primary school boys have the highest value of RR. It can be shown that the difference between this value and unity is unlikely to have arisen by chance (p=0.018). The 95% confidence intervals of the observed value of RR for primary school boys are +1.34 and +4.19. This pattern differs from the Nelson school holiday survey where it was shown that the difference between the observed RR value for primary school boys and unity could easily have arisen by chance. Table 8.36 also shows that primary school girls had zero accidents, while still accounting for about one-fifth of the exposure. It can be shown that this is not very likely to have arisen by chance ($p=0.17$). If this difference were confirmed in a larger scale study it would indicate a similar pattern to that found in the Nelson school holiday survey.

In terms of location it can be shown that the differences between the observed values of RR for each section of route and unity could easily have arisen by chance. This was also the case in the Nelson school holiday survey.

In this survey, as in the Nelson school holiday survey, the RR value for main roads is appreciably higher than that for other roads. The differences between the observed values of RR for both main and other roads can be shown to be not very likely to have arisen by chance ($p=0.09$). The likelihood of these differences being real is backed up by the fact that such differences were observed very strongly in both of the other surveys. It can also be seen that the observed value of RR for main roads in the Bristol survey lies well within the 95% confidence intervals of the observed value of RR for main roads in the Nelson school holiday survey.

Finally, it can be seen from the table that the observed value of RR for the morning period is less than that for the afternoon period. However, it can be shown that the differences between the observed values of RR for both the morning and afternoon periods and unity could easily have arisen by chance. These findings agree with those of the Nelson school holiday survey, though it should be stressed again that further larger scale surveys are needed to confirm these findings.

In the Bristol survey only 8 of the 10 accidents to children occurred on the MOBs route. The distribution of 8 accidents over the types of traffic environment did not appear to be such as to indicate any differences in risk.

8.8 Conclusions

The main aim of this chapter was to try to test the hypothesis that some of the variation in the patterns of road accidents to child pedestrians which occurred while they were using the roads for reasons other than going to and from school (see Chapters 3 and 7), could be explained by the variation in the amount and type of use that children make of the roads during periods other than those of travel to and from school.

The first part of this chapter examined some of the differences in exposure for each of the three surveys, between children of different sex and age, and for different types of locations and times of day. Levels of accompaniment of these children, and the activities that they were involved in were also considered. The results have shown that according to each survey there were differences in the amount and type of use made of the roads by children of different age and sex and in their levels of accompaniment by different groups of people. It was possible to carry out two types of comparison using the results from the three surveys. These were firstly between schooldays and school holidays in the Nelson area, and secondly between Nelson and Bristol in the school holidays.

In terms of the first of these comparisons a number of important differences were found which reflect the different nature of the two time periods. Firstly there were in total more children observed in the school holiday survey than in the schoolday survey. Most of this difference is accounted for by there being more school age (especially primary school) children observed in the holiday survey compared to the schoolday survey. In the schoolday survey the proportions of pre-school and secondary school children observed were higher than in the holiday survey, while for primary school children the opposite was the case. The number of children observed at different times of the day differed between the two surveys, in particular very few school age children were observed during school hours in the schoolday survey. This meant that in the schoolday survey most activity was concentrated into the final two periods of the day. During these periods the total number of children observed was higher in the schoolday survey than in the school holiday survey. On school holidays a greater proportion of children were observed walking/on errands than on schooldays, while for play the opposite was the case. In terms of location the types of activity which took place on each of the sections were very similar between the surveys. Finally, on schooldays pre-school children were more likely to be accompanied by adults than on school holidays. This implies that these children are less protected on school holidays than on schooldays. This might be because during the day on school holidays there are more children using the roads than on schooldays and so parents may feel that their children are safer (perhaps not just from a road safety point of view) and that there is less need to accompany them.

In terms of the second of the comparisons there are again a number of important differences between the two surveys, which reflect fundamental differences in the nature of the two areas and their population. Firstly in the Nelson school holiday survey a greater number of children were observed during the surveyed period than in the Bristol school holiday survey. This is still the case even when the differences in the size of the two surveyed areas are taken into account. A greater proportion of the children observed in the Nelson area were of primary school age, and a smaller proportion of secondary school age than in the Bristol area. This can be partly explained by differences in the age structure of the child population in the two areas. In the Bristol survey a greater proportion of children were observed in the morning periods than in the Nelson survey. In terms of activity a substantially lower proportion of children (especially pre-school and primary school children) were observed playing (on foot) in the Bristol survey compared to the Nelson survey, though a much larger proportion were observed playing on bicycles. This might reflect the differences in affluence and topography which exist between the two study areas. Finally, in the Bristol survey a greater proportion of children were observed accompanied by adults than in the Nelson survey, whereas the opposite was the case for children unaccompanied by older people (i.e alone or accompanied by contemporaries or younger children). This might indicate a greater concern for children's road safety in the Bristol area compared to Nelson, but probably also reflects the greater availability in Bristol of places other than the streets where children can spend time in the open air.

The second part of this chapter attempted to discover how much the results described in the first part could be used to explain the variability in the patterns of accidents. This was done using a measure called Relative Risk. These analyses of risk could not be very detailed due to the small numbers of accidents available, but despite this limitation some worthwhile and valid results were obtained. It has been shown for some of the variables in the surveys that exposure seems to explain the difference in the numbers of accidents well. This was particularly the case for the difference in the numbers of accidents to boys and girls on schooldays in Nelson, the difference in the numbers of accidents to children of various ages in both of the school holiday surveys, and finally the difference in the number of accidents at different times of the day in all three surveys. However, for the remaining variables for each of the three surveys exposure explains by no means all of the difference in the numbers of accidents. These latter results need to be considered in more detail here as they can be used firstly to indicate areas where further research may be worthwhile, and secondly as a basis for policy decisions regarding the design and implementation of road safety measures.

In terms of sex it was shown that in both of the school holiday surveys (though not in the schoolday survey) boys have a higher RR than girls. The reason for this could be partly to do with differences in the behaviour of boys and girls when in given traffic situations. This finding indicates the need for a further study of the behaviour patterns of boys and girls in these study areas. In terms of age it was shown in the schoolday survey that primary school children have a much higher risk of being involved in a road accident than pre-school or secondary school children. This is thought to be partly due to the high proportion of pre-school children compared to primary school children who were observed accompanied by adults, and also the greater experience of using the roads that secondary school children have compared to primary school children. These findings indicate the need for more road safety measures aimed specifically at primary school children, perhaps in the form of a greater emphasis on road safety training at school or by trying to increase their level of accompaniment or supervision by parents and older children. In terms of age and sex the exposures measured in the Bristol school holiday survey indicate primary school boys have a high relative risk and those measured in both of the school holiday surveys that primary school girls have low relative risk. Exposures measured in the schoolday survey indicate that secondary school boys have a low relative risk. In terms of location the results in both of the Nelson surveys indicate that children are less likely to be involved in a road accident on Section 3 which contains within it virtually no stretches of main road, than on any of the other sections where there are longer stretches of main road. Further detailed study of the characteristics of each of the sections could produce worthwhile information on the types of environment where it is relatively safe for children to use the streets for play and other purposes and where it is less safe for them to do so. It was shown very strongly from all of the surveys that children's risk of a road accident was very much higher on main roads compared to other roads. It is thought that this is most probably due to the higher levels of traffic and the greater complexity of the road crossing task on main roads compared to other roads. These findings indicate strongly the need for road safety measures which either make main roads safer for children to use or decrease their need to use them. These conclusions are backed up by the finding (from the two Nelson surveys only) that children's risk of a road accident is lower on roads with an average hourly flow of traffic of less than 201 vehicles, than on roads with a higher average hourly traffic flow. Finally, in a number of breakdowns of RR discussed above, particularly where more than two or three categories were used, the size of the accident sample was not sufficiently large to enable useful results to be obtained. In these cases larger scale surveys are needed to provide results which are sufficiently reliable to allow worthwhile recommendations for preventative measures to be based on them.

CHAPTER 9

SUMMARY AND CONCLUSIONS

This chapter gives a summary of the main aims of the thesis, the methods used to achieve these, and some of the results obtained. Proposals for preventative measures which are based upon the findings of the study are also discussed.

9.1 Aims of the research

The main aims of this research were: firstly, to design and test the effectiveness of two methods of collecting information on child pedestrians' exposure to risk; secondly, to investigate the relationship between the number of road accidents to child pedestrians at different times of the day and in different sorts of environment, and the amount and type of use that these children make of the roads at different times of the day and in different sorts of environment; thirdly, to identify whether children in certain age and sex groups, at particular types of locations and times of day, have a higher risk of an accident than others; and finally on the basis of the results of the investigations described above to make a number of suggestions for preventative measures which would be applicable both in the study areas and in some cases on a wider scale.

9.2 Summary of the data collection methods

The first stage of the work programme was to analyse the patterns of accidents to child pedestrians in each of 5 study areas which were the subject of wider road safety research as part of a national experiment. This accident data was collected using 'Stats 19' printouts from the Local Authorities involved, and also the more detailed police accident files. On the basis of these analyses and upon the findings of the review of literature described in Chapter 2 it was decided that the most worthwhile extension of the work that had been undertaken so far, was to obtain information on children's exposure to risk in the study areas. This data could then be combined with the accident data to produce measures of accident risk for particular groups of children at certain times and locations. Two methods were used to collect the data on exposure to risk, one examining children's exposure to risk on the journeys to and from school, and the other examining children's exposure to risk when using the roads for other purposes. The first of these was carried out using a questionnaire survey, which was introduced into most of the schools in each of the study areas. The second involved an enumerator walking along preselected routes to a predetermined pattern in two of the study areas recording details of the children observed there.

9.3 Advantages and limitations of the methods used to collect data on children's exposure to risk

There are several ways in which the methods used have proved to be successful in their aims, and to be a useful addition to the spectrum of methods available for collecting information on child pedestrians' exposure to risk. First, and perhaps foremost, both the methods used are cheap and efficient to carry out, and both are applicable to areas of different size and character. Secondly, the methods have not only been shown to produce data of a reliable nature, but they can also provide a wide variety of items of data about children's use of the roads. While both of the types of survey carried out as part of this study obtained data for a large number of variables, by no means all possible such variables were collected. Further studies of this type need not necessarily collect identical information to this one, but rather, other sets of variables could be collected, dependent upon the context and needs of each individual study. Finally it is considered that the methods used here represent a more efficient use of time and resources than some of the others discussed in Chapter 2 (in particular those used by Routledge et al,1976, Knighting et al,1972 and Chapman and Wade,1982). In the case of the surveys of children's journeys to and from school it has been shown that it is possible, with a minimum of effort and financial outlay and a high level of cooperation with school teachers, to obtain exposure data from a very large sample of children. Also in the case of the surveys of children's use of the roads for purposes other than going to and from school, it has been shown that one enumerator observing children in the streets can collect a substantial number of data items from a fairly large area.

While having a lot of advantageous aspects, there were also some problems associated with these methods. The major problem encountered when using the information obtained in both of the surveys, and combining it with the accident statistics to produce measures of accident risk, was the small number of relevant accidents which occurred in each of the study areas during the period of study. This meant that groupings of children with respect to particular variables for the purposes of comparison of accident risk could not consist of more than two or three categories, and that in some cases even with this small number of categories it could not be shown with' a reasonable level of confidence whether observed differences were real or might easily have arisen due to chance fluctuations. In future this problem could be overcome to some extent by either choosing larger areas so that a greater number of accidents were included in them, or by obtaining accidents from a greater range of years than was the case in the present surveys. If this latter solution was chosen, then care would have to be taken that the general patterns of children's use of the road system within the areas of study had not changed significantly during the period in question. One other limitation related to accidents concerns the scope of the 'Stats 19' form. This does not include any information on children's accompaniment or activity at the time of their accident. This means that, although these variables were collected in the exposure surveys, no direct measures of accident risk could be calculated for accompanied and unaccompanied children, or children involved in certain types of activity. It is recommended either that the range of information collected on the 'Stats 19' form be increased to include these two variables, or that as part of future research of this kind special studies be carried out (perhaps along similar lines to that of

Grayson,1975a in Hampshire) to collect this supplementary information.

A particular limitation of the surveys of children's journeys to and from school is that the method relies upon school children of all ages being able to understand and interpret the questionnaire, or to receive sufficient help to enable them to do so. It also assumes that they will put down the correct information in their responses to the questionnaire, though to some extent questionnaires containing illogical or incompatible information can be weeded out during the subsequent analyses. It was found in these surveys that only a very small proportion of children who completed the questionnaires appeared to do so erroneously.

The major limitation of the surveys of children's use of the roads for reasons other than going to and from school is that the enumerator has to make assumptions regarding some of the variables collected, particularly the variables age and activity. Ideally it would be better to be able to ask the observed children their age, and exactly what they are doing, but for a variety of reasons this is not feasible. Consequently, it is not possible to record very specific and accurate descriptions of age and activity. However, experience has shown that by using suitable groupings for both age and activity, useful data for these variables may be obtained. It is likely that age identification could be enhanced if training were given to enumerators before the surveys took place.

9.4 Summary of results

Three types of analysis were carried out in this study. These were firstly analyses of road accidents to child pedestrians, secondly analyses of exposure data, and finally analyses of accident risk or relative risk.

9.4.1 Summary of the results of the accident analyses.

The variation in the patterns of road accidents to different groups of child pedestrians, at different time periods and in different locations was examined. It was shown that in each of the study areas child pedestrians made up more than half of the pedestrian casualties. About 60% of the child pedestrian casualties were boys. The greatest difference in the numbers of casualties to boys and girls was between the ages of 4 and 9 years. For all other age groups boys and girls had similar numbers of accidents. A greater proportion of girls and older children were involved in accidents on main roads compared to other roads than boys or younger children. In terms of time there were more accidents in Autumn and Winter than in Spring and Summer. The highest number of accidents per day was on schooldays, followed by school holidays and weekends. Very few accidents occurred before 8am or after 8pm. Almost half of the accidents occurred between 3 and 6pm. Most of the accidents occurred in daylight. About one quarter occurred on a journey to or from school. In terms of location a large proportion of children, especially pre-school children were knocked down within 0.5km of their homes. About 40% of the accidents occurred away from junctions. Of those occurring at junctions most were at T-junctions. Very few accidents occurred at crossing facilities of any sort. The vehicles involved were mostly cars, most of which were driven by males at the time. About one third of the accidents also involved a parked vehicle. Very few of the accidents occurred outside the carriageway, but rather took place while the child was trying to cross the road. Most of the accidents occurred when the vehicle was travelling along the road normally, and not when it was undertaking difficult manoeuvres such as reversing or turning right. Finally, the descriptions of the accidents recorded on the 'Stats 19' form very often implicitly blame the child rather than the driver of the vehicle.

9.4.2 Summary of the results of the exposure to risk analyses.

This section will give a very brief outline of some of the main findings for the surveys of children's journeys to and from school and the surveys of children's use of the roads for other reasons.

The surveys of children's journeys to and from school

The variation in the patterns of exposure to risk between the study areas, between types of schools within these areas, between years within schools, between children of the two sexes and between the journeys to and from school were examined. Five measures of exposure to risk were discussed: the mode of travel, accompaniment, the number of roads crossed, the distance walked and the time spent walking. Results showed that with the exception of accompaniment, there was little variation in the measures of exposure to risk between years within schools or between the sexes of children. However, more substantial variations were found in exposure to risk between children in different types of school, in the different study areas, and on the journeys to and from school. It has been shown in terms of mode of travel that on the journey home from school a larger proportion of children walked, and a correspondingly smaller proportion of children were taken by car, than on the way to school. It was also shown that there were some variations in modal split between the study areas, in particular use of cars was much more common in the two southern areas compared to the others. In terms of accompaniment there was some evidence that girls were accompanied more than boys. It was also shown that infants and first school children had the highest levels of accompaniment by adults, and secondary school children the lowest. In terms of the number of roads crossed it was shown in four of the areas that secondary school children crossed more roads than primary school children on the journeys to and from school, while in the Sheffield area, the numbers of roads crossed by children from various types of school were more similar. In terms of distance walked, it was shown that on average children walk slightly further on the way home than on the way to school. Also on average secondary school children walk further than primary school children. Finally in terms of time, children travelling to and from secondary schools took longer than those travelling to and from primary schools.

<u>The surveys of children's use of the roads for reasons other than going to and from school</u>

The variations in the patterns of exposure to risk of children on schooldays and school holidays were examined. The measure of exposure used in these surveys was the number of children observed in the street. These surveys were carried out in two areas only. They covered most hours of the day at which appreciable numbers of children are out and about on foot, with the deliberate exception of the times of day at which journeys to and from school are made. Results showed that the patterns of use that children made of the roads, in terms of their sex, age, accompaniment, and activity and the times of day and locations at which they were observed, varied in some cases quite considerably both between schooldays and school holidays in the Nelson area and between the Nelson and Bristol areas on school holidays.

In terms of the differences found between schooldays and school holidays in the Nelson area at times other than those of journeys to and from school it was shown that more children use the roads on school holidays than on schooldays. On schooldays the proportions of pre-school and also secondary school children observed were higher than in the school holiday survey, while for primary school children the opposite was the case. In the schoolday survey very few school age children were observed during school hours. This meant that most activity was concentrated into the period between about 5.45pm and 8.00pm. Between these hours the total number of children observed was higher in the schoolday survey than in the school holiday survey. On school holidays a greater proportion of children were observed walking or on errands than on schooldays, while for play the opposite was the case. Finally, on schooldays pre-school children were more likely to be accompanied by adults than on school holidays.

In terms of the differences between the Nelson and Bristol areas on school holidays, a greater number of children were observed during the surveyed period in the Nelson area than in the Bristol area. A greater proportion of the children observed in the Nelson survey were of primary school age and a smaller proportion of secondary school age than in the Bristol survey. In the Bristol survey a greater proportion of children were observed in the morning periods than in the Nelson survey. A substantially lower proportion of children were observed playing on foot in the Bristol survey compared to the Nelson survey, though a larger proportion were observed playing on bicycles. Finally, in the Bristol survey a greater proportion of children were observed accompanied by adults than in the Nelson survey, whereas the opposite was the case for children unaccompanied by older people.

9.4.3 Summary of some of the main results of the analyses of accident risk and relative risk. The measures of accident risk and relative risk were produced by combining accident data with exposure data. Because of the different form and nature of the exposure data obtained from the two types of survey, measures of accident risk were used for the analyses of children's journeys to and from school, and measures of relative risk were used for the analyses of children's use of the roads for other reasons. This meant that results from each of the two types of surveys could not be directly compared, but rather, only general comparisons made between them. The exact definitions of these measures are described in Chapters 6 and 8. The findings of the analyses of accident risk and relative risk have direct implications for road safety in the study areas and so will be summarized for each of the sets of surveys here.

The surveys of children's journeys to and from school

For the reasons discussed in Section 9.3 the scope of the analyses of accident risk was limited due to the small sample of accidents in each of the study areas. The main results are as follows:

(1) Child pedestrians in the Bristol study area had an appreciably lower risk of a road accident on the journeys to and from school than children in each of the other study areas.

(2) For all the study areas together, accident risk was found to be higher on the journey home from school in the afternoon than on the journey to school in the morning.

(3) Children in middle/junior schools had the highest risk of an accident on the journeys to and from school.

(4) On the journeys to and from school accident risk to child pedestrians was about 10 times as high when crossing main roads, compared to crossing other roads.

(5) On the journeys to and from school the risk of an accident to child pedestrians was approximately twice as high within 0.5km of schools, as at distances greater than 0.5km from schools.

(6) On the journeys to and from school the accident risk when crossing a main road not at a crossing facility was about 3 times as high as when crossing a main road using a crossing facility.

(7) Overall there was a very small risk to any individual child of having a road accident while travelling to and from school on foot, but for each school as a whole the risk of some of its children having such an accident each year was appreciable.

<u>The surveys of children's use of the roads for reasons other than going to and from school</u>

Once again the scope of the analyses carried out was limited by the small sample of accidents available. This was particularly the case for the Bristol school holiday survey where a sample of only 10 accidents had to be used. The main results found are as follows:

(1) For a number of variables in each of the surveys it was shown that exposure seems to explain the difference in the numbers of accidents well. These were the numbers of accidents to boys and girls on schooldays in Nelson, the numbers of accidents to children of each age group in both of the school holiday surveys and the numbers of accidents at different times of the day in all three surveys.

(2) On school holidays, though not on schooldays, boys were shown to have a higher relative risk than girls.

(3) On schooldays in Nelson, though not on school holidays, primary school children had a much higher relative risk than either pre-school or secondary school children.

(4) On school holidays in both areas it was shown that primary school girls have a low relative risk, and on school holidays in Bristol that primary school boys have a high relative risk. On schooldays secondary school boys were shown to have a low relative risk.

(5) In both of the Nelson surveys it was shown that children were less likely to have an accident in sections of the area that contained virtually no main roads than in the other sections surveyed where there were a greater number of stretches of main road.

(6) All three surveys indicated that children's risk of an accident was much higher on main roads compared to other roads. Both of the Nelson surveys also indicated that children's risk of an accident was higher on roads with a high flow of traffic compared

to roads with lower flows.

9.5 Proposals for preventative measures

The results of the analyses of accident occurrence to children and of children's risk of an accident on journeys to and from school and at other times indicate several general policies which could be used to decrease the accident risk of child pedestrians. Although the data relate specifically to the study areas it is considered that a number of these recommendations are generally applicable to residential areas.

Firstly, it is considered that there is a clear need for the implementation of road safety measures aimed specifically at the journey home from school. These could take the form of extra crossing patrols in the afternoon period, stringent speed restrictions near to schools in the going home from school period of the day or education and training focussed on behaviour on the way home. Such measures would have the effect both of reducing the high accident risk in the afternoon period, and also the high accident risk in areas close to schools. Secondly, it is recommended that resources should be used to develop and implement parental and schools based training programmes aimed at creating a better awareness in children of the dangers involved both when travelling to and from school, and also when using the roads for other purposes. These measures should be aimed particularly at children of middle/junior school age. These programmes could be combined with planning measures, particularly related to the journeys to and from school where there are reasonably identifiable flows of children, aimed at making heavily used routes safer. It is considered that the implementation of such measures should be based upon detailed surveys of the routes that children take to and from schools so that new crossing facilities, or educational material aimed at identifying safe routes to schools, would have maximum effectiveness in bringing about a reduction in accident risk. It is also thought that some attempt should be made to persuade parents, where possible, to try to accompany their children more, particularly those in the primary school age range, where the children have yet to develop sufficient skills to allow them to use the roads safely, both on the journeys to and from school and at other times. It was shown in both surveys that children have a much higher risk of an accident on main roads than on other roads suggesting that particular attention should be paid to increasing children's safety in those locations. On the journeys to and from school this could involve the creation of catchment areas which are bounded by main roads rather than encompassing them. Where this is impossible, because for example catchment areas of the latter form already exist, the identification of safe routes to school, which firstly minimise main road crossings, and secondly ensure that where such crossings are essential they are made at crossing facilities, would help to reduce accident risk. This latter point is supported by evidence from the surveys of children's journeys to and from school which shows that the accident risk of crossing a main road not at a crossing facility is about three times the accident risk of crossing a main road at a crossing facility. Measures should also be aimed either at reducing children's need to use main roads for reasons other than going to and from school, or where this is not possible, making main roads safer for children to use.

9.6 Conclusion

In conclusion, it has been shown that the two methods used to collect data on children's exposure to risk which were designed as part of the research were successful, and that they may be readily applied to other studies of different size and scope. The results of these surveys have enabled some aspects of the relationship between child pedestrians' exposure to risk and the occurrence of accidents to be investigated. These investigations have shown that certain types of children in certain types of location and at certain times of the day have differing levels of risk of being involved in a road accident. Identification of high risk groups of children has provided the basis for suggestions for some preventative measures which can be applied to the study areas and in some cases on a wider scale.

Finally, it is concluded that the collection of data concerning the amount and type of use that children make of the roads is a necessary supplement to the collection of accident data, and that a knowledge of accident risk is a useful aid to the design and implementation of road safety measures.

CHAPTER 10

FURTHER WORK

Previous chapters have described the work which was carried out within the period of a research studentship and which represents a complete study in its own right. However, it is thought that the data sets collected in this study and the results of the analyses carried out so far could be used as the basis for further relevant work. It is also thought that further surveys, looking at different aspects of child pedestrian behaviour in the study areas could be carried out. This chapter will briefly describe some of the ideas the author has had for both of these types of further analysis, which could be carried out if further time and money were available.

10.1 Further analyses using the existing data sets

Further analyses of this type could be carried out using both the accident and exposure data sets. However, it is thought that the accident analyses described in Chapter 3 are fairly comprehensive in relation to the numbers of accidents for which data are available and that further analyses along those lines, except by the addition of further years of data, do not need to be considered here. This section, therefore, will consider further work which could be done using the two exposure data sets concerning children's journeys to and from school, and children's use of the roads for other purposes.

10.1.1 Further work relating to the surveys of children's journeys to and from school. Several types of analyses exist in this category, and these will be considered in turn below.

More detailed analyses

More detailed analyses of the exposure measures could be carried out, for instance examining the travel characteristics of children attending particular schools. Unfortunately, the number of accidents to children from each school was so small that analyses of their levels of accident risk will not be possible.

Feedback of information to the schools

Some feedback to the schools involved in the surveys should take place, perhaps along the lines of a discussion of, or recommendations for 'safer routes to schools'. The idea of some form of feedback to the schools resulting eventually from this project was brought up on several occasions in preliminary contact with the Road Safety Officers and with the schools involved, and no doubt helped to persuade some of them to take part. Two types of feedback are possible. Firstly, descriptions of the results and recommendations based on these, which could be acted upon, if thought appropriate, by the school authorities. Secondly, some of the schools expressed the wish to obtain copies of the raw data pertaining to their pupils, mostly in the form of a computer disk. This could then, in conjunction with the schools' microcomputers, be used as the basis of lessons, in which the children could try to draw some conclusions from the data, which may be beneficial to their perception of their own safety on the roads.

Route choice

A recent study by Hill (1984) looked in detail at the routes children take home from school, in terms of their length and relative safety, and tried to define what part these factors played in route choice. A similar method could be applied to the data sets collected in this study, especially with regard to the journey home, to find out what proportion of children take the shortest route home, and also, by using the 'wayhome' variable, to discover what the other children do on their way home from school.

Census data

Some investigation of the factors described above should be carried out in the light of the census characteristics of the areas. Aspects which could be investigated include socio-economic status and car ownership. These can be related to modal choice or accompaniment. This type of analysis could be carried out for both of the surveys.

Wider applicability of surveys

It would be interesting to consider the wider applicability of the results of both of the surveys. By using census characteristics it would be possible to identify how representative the study areas are of the cities in which the surveys took place as a whole (in the case of Bradford, Bristol, Reading and Sheffield), or indeed how representative they are of urban residential areas in the country as a whole. Some assessment of whether or not the results and conclusions drawn from these surveys are applicable on a wider scale could then be made.

Discussion of results in the context of the Urban Safety Project

The results discussed in Chapters 6 and 8 could, where relevant, be looked at in terms of the road safety schemes which have been, and are in the process of being, implemented in the 5 study areas by the Urban Safety Project. The design of these schemes did not take into consideration detailed information on the levels and characteristics of child pedestrian exposure in the study areas, and therefore it would be useful to assess whether any further allowances could have been made for child pedestrians in the light of the results of the present study.

Further analyses of accident risk

Due to the small numbers of accidents in the areas, many more detailed analyses (looking, for instance, at exposure to risk at particular junctions) will not be possible. However, it would be possible to examine in more detail a set of locations where the accident rate for the set as a whole is high, and a similar set of locations where it is low, and then compare the exposure and other background data at these. Four sorts of location could be chosen in this manner. These are where both the accident rate and exposure are high, where the accident rate is low and exposure is high, where the accident rate is high and exposure low, and finally where both of these are low. If such locations exist in the areas (and some of them will obviously be more common than others), then it would be interesting to try to define the effect that factors such as traffic flow and other aspects of the local environment have (if any) in causing these differences.

10.1.2 Further analyses relating to the surveys of children's use of the roads for reasons other than going to and from school. Three types of further analysis will be considered here.

Activity patterns

It would be possible to examine in more detail the behaviour of children in the study areas than has been done so far. This could be done by further analysis of the variable 'activity'. To supplement this, surveys could be carried out to examine children's behaviour in the study areas by direct observation (see Section 10.2). It would be possible using the data already obtained to identify the types of areas where children play, and the sorts of use that they make of these areas.

Larger studies

It would be useful to calculate how much more work or how many more enumerators would be needed to carry out a survey of a wider area, for instance the whole (every road) of a town such as Nelson, and how this could be done. It is thought that a small number of enumerators could cover a very wide area using the method of data collection described in Chapter 7. These results would be useful if any new larger scale studies of this type were to be carried out.

Types of area

Sandels (1975) identified 'dangerous' and 'safe' areas for children's play. Similar definitions could be made for these study areas, and the rates of usage of these dangerous and safe places, by children of different age and sex groups and for different activities, could be calculated.

10.1.3 Relevance of both surveys to road safety education. The patterns of use of the road system that is revealed in the two surveys taken together could be examined in relation to current and proposed policies for road safety education, to see whether any changes in content or emphasis are indicated either generally or for children of particular ages or in other particular groups or circumstances.

10.2 Further surveys related to those already carried out

Two types of further survey will be mentioned here, both of which are thought feasible in the context of the study areas, and likely to produce results which would be a relevant and useful addition to those already obtained.

Further exposure surveys

Both of these surveys could be repeated. This would allow some time series of the results to be built up. These would be useful in the light of the changing trends in accident patterns at present. Recently, the numbers of pedestrian accidents involving children aged 5-9 years per head of population has fallen, while those involving children aged 10-14 years has risen (DTp.,1984). Thus further surveys of a similar nature to those already carried out in the study areas would help to identify possible reasons for this change. Further surveys would also allow comparison of the data obtained before the implementation of the Urban Safety Project schemes with that obtained after their implementation.

Surveys of children's behaviour

It would also be possible to carry out surveys of children's behaviour in the road environment consisting of, for instance, studies of gap acceptance when crossing the road, the relationship of behaviour to accompaniment, and the crossing strategy of different groups/types of children in different types of location. It would also be useful to compare the patterns of children's behaviour on the roads in the study areas with that of adults.

10.3 Conclusion

This chapter shows that the research carried out as part of this study has indicated a number of areas where further related research would be useful. These include both further work which is related to the data sets already collected, and also further data collection which it is considered would provide a useful supplement to some of the findings already discussed.

REFERENCES

AVERY, J.G AND AVERY, P.J (1982) Scandinavian and Dutch lessons in childhood road traffic accident prevention. British Medical Journal Vol 285 pp 621-626.

BACKETT, E.M. AND JOHNSTON, A.M (1959) Social patterns of road accidents to children: some characteristics of vulnerable families. British Medical Journal Vol 1959-I pp 409-13.

BAKER, R.J. AND NELDER, J.A (1978) The GLIM System Manual (Release 3). The Numerical Algorithms Group, Oxford.

BELL, G. AND TETHER, C.P.A (1983) Travel to school in a London Borough. Traffic Engineering and Control Vol 24(9) pp 454-459.

BOCHER,W (1978) Why children should be involved in planning the traffic environment as part of the road safety education. Safety Education Number 144, pp 28-30

BROG, W. AND KUFFNER,B. (1981) Relationship of accident frequency to travel exposure. Transportation Research Record Vol 808 pp 55-61.

BULL,J.P. AND ROBERTS,B.J. (1973) Road accident statistics-a comparison of police and hospital information. Accident Analysis and Prevention Vol 5(1) pp 45-53.

CAMERON, M.H (1982) A method of measuring exposure to pedestrian accident risk. Accident Analysis and Prevention Vol 14 (5), pp 397-405.

CAMERON, M.H., STANTON, H.G. AND MILNE,P.W (1976) Pedestrian accidents and exposure in Australia. Proceedings of the Int. Conf. on Ped. Safety, Vol 1 . Haifa, Israel.

CATTELL,R AND LEWIS,G.D (1975) Children's understanding of words used in road safety literature. Department of the Environment Department of Transport, TRRL report SR 155UC, Crowthorne.

CENTRAL STATISTICAL OFFICE (1986 and other years) Social Trends 16: 1986 edition. HMSO.

CHAPMAN,A.J., FOOT,H.C., SHEEHY,N.P. AND WADE,F.M (1981) The social psychology of child pedestrian accidents. In EISER,J.R. (1981) Social psychology and behavioural medicine. Wiley.

CHAPMAN,A.J.,FOOT,H.C. AND WADE,F.M. (1980) Children at play. In OBORNE,D.J. AND LEVIS,J.A. (1980) Human factors in transport research. Academic press.

CHAPMAN, A.J. AND WADE, F.M (1982) Recreational use of the street by boys and girls: an observational and developmental study. In BREAKWELL, G.M., FOOT,H. AND GILMOUR,R (1982) Social psychology: a practical manual. MacMillan, London.

CHAPMAN,A.J., WADE,F.M. AND FOOT,H.C. (1982) Pedestrian accidents. Wiley.

CHAPMAN,R. (1973) The concept of exposure. Accident analysis and prevention Vol 5 pp 95-110.

COLBOURNE,H.V. (1971) Two experiments on methods of training children in road safety. Department of the Environment Department of Transport, TRRL report LR 404, Crowthorne.

COCTE,M (1976) Why young children dash into the road- An investigation in terms of child development. Safety Education Vol 138, Autumn.

CYSTER,R. (1981) The use of video-tape recordings of childrens road behaviour for road safety teaching. Department of the Environment Department of Transport, TRRL report SR 684, Crowthorne.

DALEY,E. (1979) Area-wide measures in urban road safety. A background to current research. Department of the Environment Department of Transport, TRRL report SR 517, Crowthorne.

DEPARTMENT OF EDUCATION AND SCIENCE/WELSH OFFICE (1985) The educational system of England and Wales. HMSO.

DEPARTMENT OF TRANSPORT (1978) Instructions for the completion of road accident reports. HMSO.

DEPARTMENT OF TRANSPORT (1983a) National travel survey: 1978/9 report. HMSO.

DEPARTMENT OF TRANSPORT (1983b) Road accidents Great Britain 1982. HMSO.

DEPARTMENT OF TRANSPORT (1984) Road accidents Great Britain 1983. HMSO.

DOWNING,C.S (1981) Improving parental road safety practice and education with respect to preschool children. In FOOT,H.C., CHAPMAN,A.J. and WADE,F.M (1981) Road safety: research and practice. Praeger.

DRISCOLL,C. AND ASHTON,S.J (1981) An analysis of child pedestrian accidents with particular reference to school journey accidents. Accident research unit, Department of Transportation and Environmental Planning, University of Birmingham.

ELLIOT,B (1985) Children and road accidents. An analysis of the problems and some suggested solutions. Australian Federal Department of Transport Federal Office of Road Safety.

FAULKNER,C.R. (1975) Distribution of accidents in urban areas of Great Britain. Department of the Environment Department of Transport, TRRL Report SR 159 UC, Crowthorne.

FINLAYSON,H.M. (1972) Childrens road behaviour and personality. British Jnl. of Educ. Psych. Vol 42(3) pp 225-32.

FIRTH,D.E. (1973) The road safety aspects of the Tufty Club. Department of the Environment Department of Transport, TRRL report LR 604, Crowthorne.

FIRTH,D.E. (1982) Pedestrian behaviour. In CHAPMAN,A.J, FOOT,H. AND WADE,F.M. (eds) (1982) Pedestrian accidents. Wiley.

FISK,A AND CLIFFE,H (1975) The effects of teaching the green cross code to young children. Department of the Environment Department of Transport, TRRL report SR 168UC, Crowthorne.

FOOT,H.C., CHAPMAN,A.J. AND WADE,F.M.(Eds.) (1981) Road safety: Research and practice. Praeger, Eastbourne.

GODFREY,C.V. (1937) Roadsense for children. Oxford University Press.

GOODWIN,P.B. AND HUTCHINSON,T.P. (1977) The risk of walking. Transportation Vol 6 pp 217-230.

GRAYSON,G.B. (1975a) The Hampshire child pedestrian accident study. Department of the Environment Department of Transport, TRRL report LR 668, Crowthorne.

GRAYSON,G.B. (1975b) Observations of pedestrian behaviour at four sites. Department of the Environment Department of Transport, TRRL report LR 670, Crowthorne.

GRAYSON,G.B. (1981) The identification of training objectives: what shall we tell the children. Accident Analysis and Prevention Vol 13 (3) pp 169-175.

GRIMSHAW,J AND MATHEW,D (1985a) Abstract of findings and proposals. London Safe Routes to Schools Project.

GRIMSHAW,J AND MATHEW,D (1985b) The geography of pupils' journeys. London Safe Routes to Schools Project.

GRIMSHAW,J AND MATHEW,D (1985c) Pupils' accidents on the school journey. London Safe Routes to Schools Project.

GRIMSHAW,J AND MATHEW,D (1985d) Proposals for improving safety of pupils' journeys. London Safe Routes to Schools Project.

GRIMSHAW,J AND MATHEW,D (1985e) The European experience. London Safe Routes to Schools Project.

HEIMSTRA,N.W., NICHOLLS,J. AND MARTIN,G. (1969) An experimental methodology for analysis of child pedestrian behaviour. Pediatrics Vol 44 pp 832-838.

HERATY,M.J. (1986) Review of pedestrian safety research. Department of Transport Department of the Environment TRRL Report CR 20, Crowthorne.

HILL,M.R. (1984) Walking straight home from school: Pedestrian route choice by young children. Transportation Research Record Vol 959 pp 51-55.

HILLMAN,M AND WHALLEY,A (1979) Walking is transport. Policy Studies Institute Vol XLV(583).

HOWARTH,C.I. (1982) The need for regular monitoring of the exposure of pedestrians and cyclists to traffic. Accident Analysis and Prevention Vol 14(5), pp 341-344.

HOWARTH C.I. AND GUNN,M.J. (1982) Pedestrian safety and the law. In CHAPMAN,A.J. ET AL. (1982) Pedestrian accidents. Wiley.

HOWARTH,C.I AND LIGHTBURN,A (1980) How drivers respond to pedestrians and vice versa. In OBORNE,D.J AND LEVIS,J.A (Eds) (1980) Human factors in transport research. Academic Press.

HOWARTH,C.I., AND LIGHTBURN,A. (1981) A strategic approach to child pedestrian safety. In FOOT,H. ET AL (1981) Road safety: Research and practice. Praeger, Eastbourne.

HOWARTH,C.I. AND REPETTO-WRIGHT,R. (1978) The measurement of risk and the attribution of responsibility for child pedestrian accidents. Safety Education Vol 144 Autumn.

HOWARTH,C.I.,ROUTLEDGE,D.A. AND REPETTO-WRIGHT,R. (1974) An analysis of road accidents involving child pedestrians. Ergonomics Vol 17(3) pp 319-330.

JACOBS,G.D. AND SAYER,I (1983) Road accidents in developing countries. Accident analysis and prevention Vol 15(5) pp 337-353.

JOHNSON,H.D. (1956) Slough experiment report no. 45. Some suggestions on routes for children to use to or from school. Department of the Environment Department of Transport, RRL Research Note RN/2804/HDJ.

JOHNSON,H.D. AND MUNDEN,J.M. (1957) Slough experiment report no.72. Effect of instruction on childrens routes to and from school. Department of the Environment Department of Transport, RRL Research Note RN/3109.HDJ.JMM.

JOLLY,K.W (1977) Trends in curriculum reform and their implications for the future of road safety education in schools. Safety education Vol 140(Summer), pp 3-5.

JONAH,B.A. AND ENGEL,G.R. (1983) Measuring the relative risk of pedestrian accidents. Accident Analysis and Prevention Vol 15(3), pp 193-206.

KNIGHTING,F.A.,COLBOURNE,H.V. AND GRAYSON,G.B. (1972) A pilot study of child pedestrians in a residential area. Department of the Environment Department of Transport, TRRL report TN 736, Crowthorne.

KNOBLAUCH,R.L., TOBEY,H.N. AND SHUNAMAN,E.M. (1984) Pedestrian characteristics and exposure measures. Transportation Research Record Vol 959 pp 35-41.

LIMBOURG,M. AND GERBER,D. (1981) A parent training program for the road safety education of pre-school children. Accident Analysis and Prevention Vol 13(3),pp 255-267.

LINTELL,J. (1979) Child pedestrians in road accidents. Journal of Action for the Crippled Child Autumn, pp 2-6.

McGARVIE,A, DAVIES,R.F AND SHEPPARD,E.J (1980) A study of a road safety film for children. Department of the Environment Department of Transport, TRRL report SR 578, Crowthorne.

MANHEIMER,D.I. AND MELLINGER,G.D (1967) Personality characteristics of the child accident repeater. Child Development Vol 38 pp 491-513.

MARTIN,G.L. AND HEIMSTRA,N.W. (1973) The perception of hazard by children. Journal of Safety Research Vol 5(4), pp 238-246.

MENSINK,G.M. (1973) Mode of travel to secondary schools. Traffic Engineering and Control Vol 15(2), pp 82-85.

MICHON,J.A (1981) Traffic education for young pedestrians: an introduction. Accident Analysis and Prevention Vol 13(3), pp 163-169.

NEWSON,J. AND NEWSON,E. (1976) Seven year olds in the home environment. Pelican.

NICHOLL,J (1980) The use of hospital in-patient data in the analysis of the injuries sustained by road accident casualties. Department of the Environment Department of Transport, TRRL report SR 628, Crowthorne.

OKAMOTO,Y (1978) Children as observed in traffic accidents. IATSS Research Vol 2, pp 119-126.

OLDER,S.J. AND GRAYSON,G.B. (1974) Perception and decision in the pedestrian task. Department of the Environment Department of Transport, TRRL report SR 49UC, Crowthorne.

O.E.C.D. (1978) Special Research Group on Traffic Safety: Chairmans report and report of sub group II - Road safety education. Crowthorne.

O.E.C.D. (1983) Traffic safety of children. Paris.

PEASE,K AND PRESTON,B (1967) Road safety education for young children. British Journal of Educational Psychology Vol 37(3), pp 305-312.

PHAROAH,T.M. (1983) Improving the safety of local streets. Research Monograph,Department of Town Planning,Polytechnic of the South Bank.

PRESTON,B. (1972) Statistical analysis of child pedestrian accidents in Manchester and Salford. Accident Analysis and Prevention Vol 4 pp 323-332.

PRESTON,B. (1980) The effectiveness of childrens road safety education. In OBORNE,D.J. AND LEVIS,J.A. (1980) Human factors in transport research. Academic press.

READING,J.B (1973) Pedestrian protection through behaviour modification. Traffic Engineering and Control Vol 43(10), pp 14-23.

REISS,M.L. (1977) Young pedestrian behaviour. Transportation Engineering Vol 47(10), pp 40-44.

RIGBY,J.P. (1979) A review of research on school travel patterns and problems. Department of the Environment Department of Transport, TRRL Report SR 460, Crowthorne.

RIGBY.J.P. AND HYDE,P.J. (1977) Journeys to school: a survey of secondary schools in Berkshire and Surrey. Department of the Environment Department of Transport, TRRL report LR 776, Crowthorne.

ROTHENGATTER,J.A. (1981) The influence of instructional variables on the effectiveness of traffic education. Accident Analysis and Prevention Vol 13(3) pp 241-253.

ROUTLEDGE,D.A.,REPETTO-WRIGHT,R. AND HOWARTH,C.I. (1974a) The exposure of young children to accident risk as pedestrians. Ergonomics Vol 17(4) pp 457-480.

ROUTLEDGE,D.A.,REPETTO-WRIGHT,R. AND HOWARTH,C.I. (1974b) A comparison of interviews and observation to obtain measures of childrens exposure to risk as pedestrians. Ergonomics Vol 17(5), pp 623-638.

ROUTLEDGE,D.A.,REPETTO-WRIGHT,R. AND HOWARTH,C.I. (1976) Four techniques of measuring the exposure of young children to accident risk as pedestrians. Proc.Int.conf.on ped.safety, Haifa, Israel.

RUSSAM,K. (1975) Road safety of children in the United Kingdom. Department of the Environment Department of Transport, TRRL report LR 678, Crowthorne.

SADLER,J. (1972) Children and road safety: a survey amongst mothers. OPCS,social survey division report SS450. HMSO.

SANDELS,S (1970) Young children in traffic. British Journal of Educational Psychology Vol 40(2), pp 111-116.

SANDELS,S (1974) The Skandia Report II: Why are children injured in traffic? Can we prevent child accidents in traffic? Skandia, Stockholm.

SANDELS,S. (1975) Children in traffic. Paul Elek, London.

SARGENT,K.J. AND SHEPPARD,D. (1974) The development of the green cross code. Department of the Environment Department of Transport, TRRL report LR 605, Crowthorne.

SAS INSTITUTE INCORPORATED (1982) SAS users guide: Basics. Cary, North Carolina.

SATTERTHWAITE,S (1976) Car driver accident involvement rates by age and sex. Transport Studies Group, University College London (unpublished).

SCHIOLDBORG,P (1976) Children, traffic and traffic training. In report on the Geiloo Congress. The Voice of the pedestrian VI, pp 12-19. International Federation of pedestrians. The Hague.

SHEPPARD,D. (1976) Teachers' views about teaching road safety. Dpeartment of the Environment Department of Transport, TRRL report SR 185UC, Crowthorne.

SINGH,A (1976) Road safety education in primary and middle schools. Department of the Environment Department of Transport, TRRL report SR 207UC, Crowthorne.

SINGH,A. (1982) Pedestrian education. In CHAPMAN,A.J. ET AL (1982) Pedestrian accidents. Wiley.

SKANDIA INSURANCE COMPANY (1971) The Skandia report. A report on children in traffic. Skandia,Stockholm.

TIGHT,M.R. (1984) Accidents to child pedestrians in selected areas of five towns and cities. 16th Ann. Conf. Univ. Transp. Study Group, Loughborough University, January (unpublished).

TODD,J.E. AND WALKER,A. (1980) People as pedestrians. OPCS Social Survey Division Report SS 1066. HMSO.

VAN DER MOLEN,H.H. (1977) Observational studies of childrens road crossing behaviour: a review of the literature. Proc. Int. Conf. on Ped. safety. Haifa,Israel.

VAN DER MOLEN,H.H. (1981) Child pedestrians exposure,accidents and behaviour. Accident Analysis and Prevention Vol 13(3), pp 193-224.

VINJE,M.P. (1981) Children as pedestrians: abilities and limitations. Accident Analysis and Prevention Vol 13(3), pp 225-240.

WADE,F.M, FOOT,A.C. AND CHAPMAN,A.J. (1982) Accidents and the physical environment. In CHAPMAN,A.J. ET AL(eds) (1982) Pedestrian accidents. Wiley.

WALLIN,J.A. (1979) Child traffic accidents- an investigation of accident factors. Scand.Jnl. of Social Medicine Vol 7 pp 143-149.

WILSON,D.G. AND GRAYSON,G.B. (1980) Age related differences in the road crossing behaviour of adult pedestrians. Department of the Environment Department of Transport, TRRL report LR 933, Crowthorne.

WOLFE,A.C. (1982) The concept of exposure to the risk of a road traffic accident and an overview of exposure data collection methods. Accident Analysis and Prevention Vol 14(5), pp 337-340.

APPENDICES

APPENDIX A.1: The English school system

In England there are essentially two hierarchies of school systems. Both begin at the age of 5 at the lowest age for compulsory full time education. In the traditional system children spend years 5 to 7 in Infants schools or departments. At age 7 they progress on to Junior schools or departments. Then at the age of 11 they go on to secondary schools, until at least the age of 16 when they have the option of leaving school, or continuing for a further two or three years in full time education.

A number of Local Education Authorities have established newer, slightly different systems, designed primarily to lessen the trauma associated with the transfer from Junior to Secondary school. In these systems children go to First schools from age 5 to 8 or 10 years. Then they attend Middle schools for various age ranges between 9 and 14 years. After this they go on up to a secondary school (Department of Education and Science/Welsh Office,1985).

It is also relevant to note here that in the new system, First schools often share sites with Nursery schools, where children of even younger ages are introduced to the idea of schooling. This is not compulsory, though it is estimated that over half of 4 year olds and one fifth of 3 year olds are receiving education in nursery schools, or in infants classes in Primary schools.

APPENDIX A.2: The Stats 19 form.

Department of Transport

ACCIDENT RECORD ATTENDANT CIRCUMSTANCES

1·1 RECORD TYPE (1 2)
1 New accident record
6 Amended accident record

1·2 POLICE FORCE (3 4)

1·3 ACCIDENT REF NO (5 6 7 8 9 10 11)

1·4 SEVERITY OF ACCIDENT (12)
1 Fatal 2 Serious 3 Slight

1·5 NUMBER OF VEHICLES (13 14 15)

1·6 NUMBER OF CASUALTY RECORDS (16 17 18)

1·7 DATE (Day Month Year; 19 20 21 22 23 24)

1·8 DAY OF WEEK (25)
1 Sunday 2 Monday
3 Tuesday 4 Wednesday
5 Thursday 6 Friday
7 Saturday

1·9 TIME (Hrs Mins; 26 27 28 29) 24 hour

1·10 LOCAL AUTHORITY (30 31 32)

1·11 LOCATION (33 34 35 36 37 Easting; 38 39 40 41 42 Northing)
10 digit reference No

1·12 1st ROAD CLASS (43)
1 Motorway
2 A (M)
3 A
4 B
5 C
6 Unclassified
7 Local
8 Authority
9 use only

1·13 1st ROAD NUMBER (44 45 46 47)

1·14 CARRIAGEWAY TYPE OR MARKINGS (48)
1 Roundabout (on circular highway)
2 One way Street
3 Dual carriageway - 2 lanes
4 Dual carriageway - 3 or more lanes
5 Single carriageway - single track road
6 Single carriageway - 2 lanes (one each direction)
7 Single carriageway - 3 lanes (two way capacity)
8 Single carriageway - 4 or more lanes (two way capacity)
9 Unknown

1·15 SPEED LIMIT (49 50 51) mph

1·16 JUNCTION DETAIL (52 53)
0 Not at or within 20 metres of junction
1 Roundabout
2 Mini roundabout
3 T or staggered junction
4 Y junction
5 Slip road
6 Crossroads
7 Multiple junction
8 Using private drive or entrance
9 Other junction

JUNCTION ACCIDENTS ONLY

1·17 JUNCTION CONTROL (54)
1 Authorised person
2 Automatic traffic signal
3 Stop sign
4 Give way sign or markings
5 Uncontrolled

1·18 2nd ROAD CLASS (55)
1 Motorway
2 A (M)
3 A
4 B
5 C
6 Unclassified
7 Local
8 Authority
9 use only

1·19 2nd ROAD NUMBER (56 57 58 59)

1·20 PEDESTRIAN CROSSING FACILITIES (60 61)
0 No crossing facilities within 50 metres
1 Zebra
2 Zebra crossing controlled by school crossing patrol
3 Zebra crossing controlled by other authorised person
4 Pelican
5 Other light controlled crossing
6 Other sites controlled by school crossing patrol
7 Other sites controlled by other authorised person
8 Central refuge—no other controls
9 Footbridge or subway

1·21 LIGHT CONDITIONS (62)
DAYLIGHT
1 Street lights 7 metres or more high
2 Street lights under 7 metres high
3 No street lighting
4 Daylight street lighting unknown
DARKNESS
5 Street lights 7 metres or more high lit
6 Street lights under 7 metres high lit
7 No street lighting
8 Street lights unlit
9 Darkness street lighting unknown

1·22 WEATHER (63)
1 Fine (without high winds)
2 Raining (without high winds)
3 Snowing (without high winds)
4 Fine with high winds
5 Raining with high winds
6 Snowing with high winds
7 Fog (or mist if hazard)
8 Other
9 Unknown

1·23 ROAD SURFACE CONDITION (64)
1 Dry
2 Wet / Damp
3 Snow
4 Frost / Ice
5 Flood (surface water over 3cms (1inch) deep)

1·24 SPECIAL CONDITIONS AT SITE (65)
0 None
1 Automatic Traffic Signal-out
2 Automatic Traffic Signal partially defective
3 Permanent road signing defective or obscured
4 Road works present
5 Road surface defective

1·25 CARRIAGEWAY HAZARDS (66)
0 None
1 Dislodged vehicle load in carriageway
2 Other object in carriageway
3 Involvement with previous accident
4 Dog in carriageway
5 Other animal in carriageway

1·26 OVERTAKING MANOEUVRE PATTERNS (67)
No longer required by the Department of Transport

1·27 DTp SPECIAL PROJECTS (68 69 70 71)

Stats 19 (Rev Nov 1983)

VEHICLE RECORD

2·1 RECORD TYPE (1 2) [2][ ]
1 New vehicle record
6 Amended vehicle record

2·2 POLICE FORCE (3 4) [ ][ ]

2·3 ACCIDENT REF NO (5 6 7 8 9 10 11) [ ][ ][ ][ ][ ][ ][ ]

2·4 VEHICLE REF NO (12 13 14) [ ][ ][ ]

2·5 TYPE OF VEHICLE (15 16) [ ][ ]
01 Pedal cycle
02 Moped
03 Motor scooter
04 Motor cycle
05 Combination
06 Invalid Tricycle
07 Other three wheeled car
08 Taxi
09 Car (Four wheeled)
10 Minibus/Motor caravan
11 P S V
12 Goods not over 1½ tons U W (1 52 tonnes)
13 Goods over 1½ tons U W (1 52 tonnes)
14 Other motor vehicle
15 Other non motor vehicle

2·6 TOWING AND ARTICULATION (17) [ ]
0 No tow/articulation
1 Articulated vehicle
2 Double/multiple trailer
3 Caravan
4 Single trailer
5 Other tow

2·7 MANOEUVRES (18 19) [ ][ ]
01 Reversing
02 Parked
03 Waiting to go ahead but held up
04 Stopping
05 Starting
06 U Turn
07 Turning left
08 Waiting to turn left
09 Turning right
10 Waiting to turn right
11 Changing lane to left
12 Changing lane to right
13 Overtaking moving vehicle on its offside
14 Overtaking stationary vehicle on its offside
15 Overtaking on nearside
16 Going ahead left hand bend
17 Going ahead right hand bend
18 Going ahead other

2·8 VEHICLE MOVEMENT COMPASS POINT (20 21) [ ][ ] From To
1 N
2 NE
3 E
4 SE
5 S
6 SW
7 W
8 NW
or [0][0] Parked not at kerb
[ ][0] Parked at kerb

2·9 VEHICLE LOCATION AT TIME OF ACCIDENT (22 23) [ ][ ]
01 Leaving the main road
02 Entering the main road
03 On main road
04 On minor road
05 On service road
06 On lay by or hard shoulder
07 Entering lay by or hard shoulder
08 Leaving lay by or hard shoulder
09 On a cycleway
10 Not on carriageway

2·10 JUNCTION LOCATION OF VEHICLE AT FIRST IMPACT (24) [ ]
0 Not at junction (or within 20 metres/22 yards)
1 Vehicle approaching junction/vehicle parked at junction approach
2 Vehicle in middle of junction
3 Vehicle cleared junction/vehicle parked at junction exit
4 Did not impact

2·11 SKIDDING AND OVERTURNING (25) [ ]
0 No skidding jackknifing or overturning
1 Skidding
2 Skidded and overturned
3 Jackknifed
4 Jackknifed and overturned
5 Overturned

2·12 HIT OBJECT IN CARRIAGEWAY (26 27) [ ][ ]
00 None
01 Previous accident
02 Road works
03 Parked vehicle - lit
04 Parked vehicle - unlit
05 Bridge (roof)
06 Bridge (side)
07 Bollard/refuge
08 Open door of vehicle
09 Central island of roundabout
10 Kerb
11 Other object

2·13 VEHICLE LEAVING CARRIAGEWAY (28) [ ]
0 Did not leave carriageway
1 Left carriageway nearside
2 Left carriageway nearside and rebounded
3 Left carriageway straight ahead at junction
4 Left carriageway offside onto central reservation
5 Left carriageway offside onto central reservation and rebounded
6 Left carriageway offside crossed central reservation
7 Left carriageway offside
8 Left carriageway offside and rebounded

2·14 HIT OBJECT OFF CARRIAGEWAY (29 30) [ ][ ]
00 None
01 Road sign/ Traffic signal
02 Lamp post
03 Telegraph pole/Electricity pole
04 Tree
05 Bus stop/Bus shelter
06 Central crash barrier
07 Nearside or offside crash barrier
08 Submerged in water (completely)
09 Entered ditch
10 Other permanent object

2·15 VEHICLE PREFIX/SUFFIX LETTER (31) [ ]
PREFIX/SUFFIX LETTER or one of the following codes –
0 More than twenty years old (at end of year)
1 Unknown/cherished number/ not applicable
2 Foreign/diplomatic
3 Military
4 Trade plates

2·16 FIRST POINT OF IMPACT (32) [ ]
0 Did not impact
1 Front
2 Back
3 Offside
4 Nearside

2·17 OTHER VEHICLE HIT (VEH REF NO) (33 34 35) [ ][ ][ ]

2·18 PART(S) DAMAGED (36 37 38) [ ][ ][ ]
0 None
1 Front
2 Back
3 Offside
4 Nearside
5 Roof
6 Underside
7 All four sides

2·19 NO OF AXLES (39) [ ]
0 Not goods vehicle
2 2 axles
3 3 axles
4 4 axles
5 5 or more axles
(Goods Vehicles only)

2·20 MAXIMUM PERMISSIBLE GROSS WEIGHT (40 41) [ ][ ]
Metric tonnes (Goods vehicle only)

2·21 SEX OF DRIVER (42) [ ]
1 Male
2 Female
3 Not traced

2·22 AGE OF DRIVER (43 44) [ ][ ]
(Years estimated if necessary)

2·23 BREATH TEST (45) [ ]
0 Not applicable
1 Positive
2 Negative
3 Not requested
4 Failed to provide
5 Driver not contacted at time

2·24 HIT AND RUN (46) [ ]
0 Other
1 'Hit and run'
2 Non-stop vehicle not hit

2·25 DTp SPECIAL PROJECTS (47 48 49 50) [ ][ ][ ][ ]

Stats 19 (Rev Nov 1983)

CASUALTY RECORD

3·1 RECORD TYPE (1 2) [3][ ]
1 New casualty record
8 Amended casualty record

3·2 POLICE FORCE (3 4) [ ][ ]

3·3 ACCIDENT REF NO (5 6 7 8 9 10 11) [ ][ ][ ][ ][ ][ ][ ]

3·4 VEHICLE REF NO. (12 13 14) [ ][ ][ ]

3·5 CASUALTY REF NO. (15 16 17) [ ][ ][ ]

3·6 CASUALTY CLASS (18) [ ]
1 Driver or rider
2 Vehicle or pillion passenger
3 Pedestrian

3·7 SEX OF CASUALTY (19) [ ]
1 Male
2 Female

3·8 AGE OF CASUALTY (20 21) [ ][ ]
(Years, estimated if necessary)

3·9 SEVERITY OF CASUALTY (22) [ ]
1 Fatal
2 Serious
3 Slight

3·10 PEDESTRIAN LOCATION (23 24) [ ][ ]
00 Not pedestrian
01 In carriageway crossing on pedestrian crossing
02 In carriageway crossing within zig-zag lines approach to the crossing
03 In carriageway crossing within zig-zag lines exit the crossing
04 In carriageway crossing elsewhere within 50 metres of pedestrian crossing
05 In carriageway crossing elsewhere
06 On footway or verge
07 On refuge or central island or reservation
08 In centre of carriageway not on refuge or central island
09 In carriageway not crossing
10 Unknown

3·11 PEDESTRIAN MOVEMENT (25) [ ]
0 Not pedestrian
1 Crossing from drivers nearside
2 Crossing from drivers nearside—masked by parked or stationary vehicle
3 Crossing from drivers offside
4 Crossing from drivers offside—masked by parked or stationary vehicle
5 In carriageway stationary—not crossing (standing or playing)
6 In carriageway stationary—not crossing (standing or playing)—masked by parked or stationary vehicle
7 Walking along in carriageway facing traffic
8 Walking along in carriageway back to traffic
9 Unknown

3·12 PEDESTRIAN DIRECTION (26) [ ]
Compass point bound
1 N
2 NE
3 E
4 SE
5 S
6 SW
7 W
8 NW
or 0 Pedestrian standing still

3·13 SCHOOL PUPIL CASUALTY (27) [ ]
0 Not a school pupil
1 Pupil on journey to/from school
2 Pupil NOT on journey to/from school

3·14 SEAT BELT USAGE (28) [ ]
0 Not car or van
1 Safety belt in use
2 Safety belt fitted not in use
3 Safety belt not fitted
4 Child safety belt/harness fitted-in use
5 Child safety belt/harness fitted-not in use
6 Child safety belt/harness not fitted
7 Unknown

3·15 CAR PASSENGER (29) [ ]
0 Not car passenger
1 Front seat car passenger
2 Rear seat car passenger

3·16 PSV PASSENGER (30) [ ]
0 Not a PSV passenger
1 Boarding
2 Alighting
3 Standing passenger
4 Seated passenger

3·17 DTp SPECIAL PROJECTS (31 32 33 34) [ ][ ][ ][ ]

Stats 19 (Rev Nov 1983)

APPENDIX A.3: Distribution of accidents to child pedestrians by the sex of the child in each of the five study areas for the years 1979-1984.

APPENDIX A.4: Road hierarchy of the study areas.

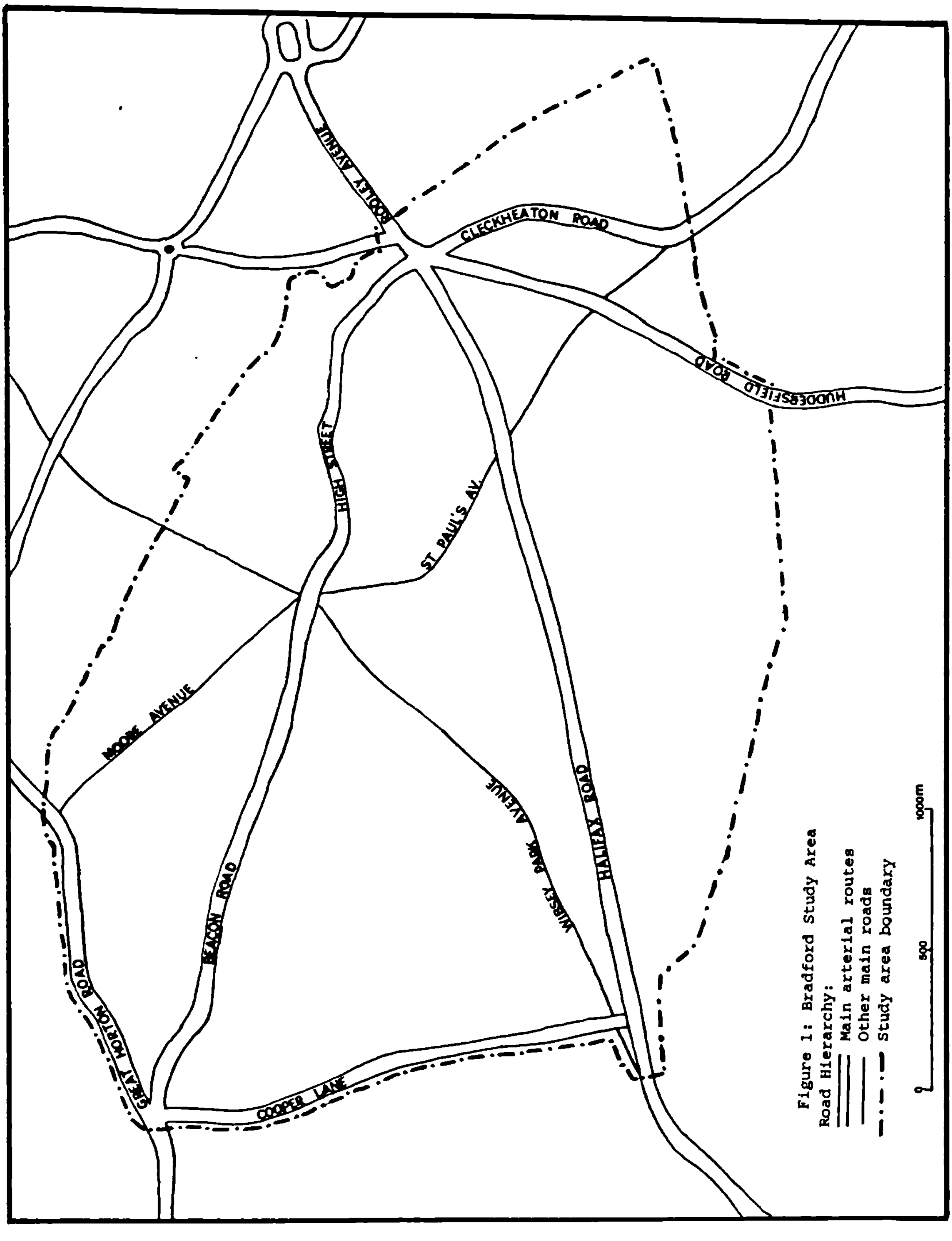


Figure 1: Bradford Study Area

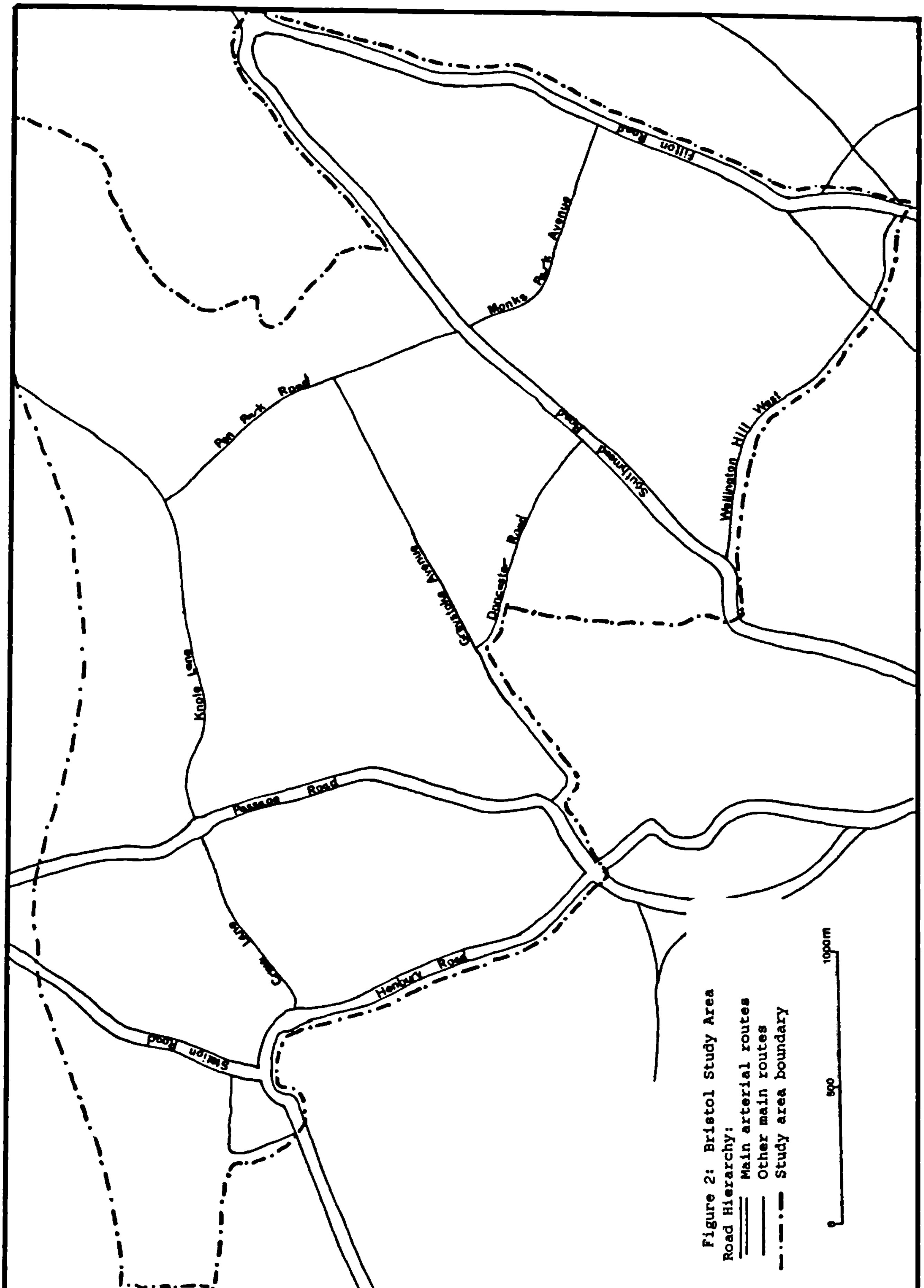


Figure 2: Bristol Study Area

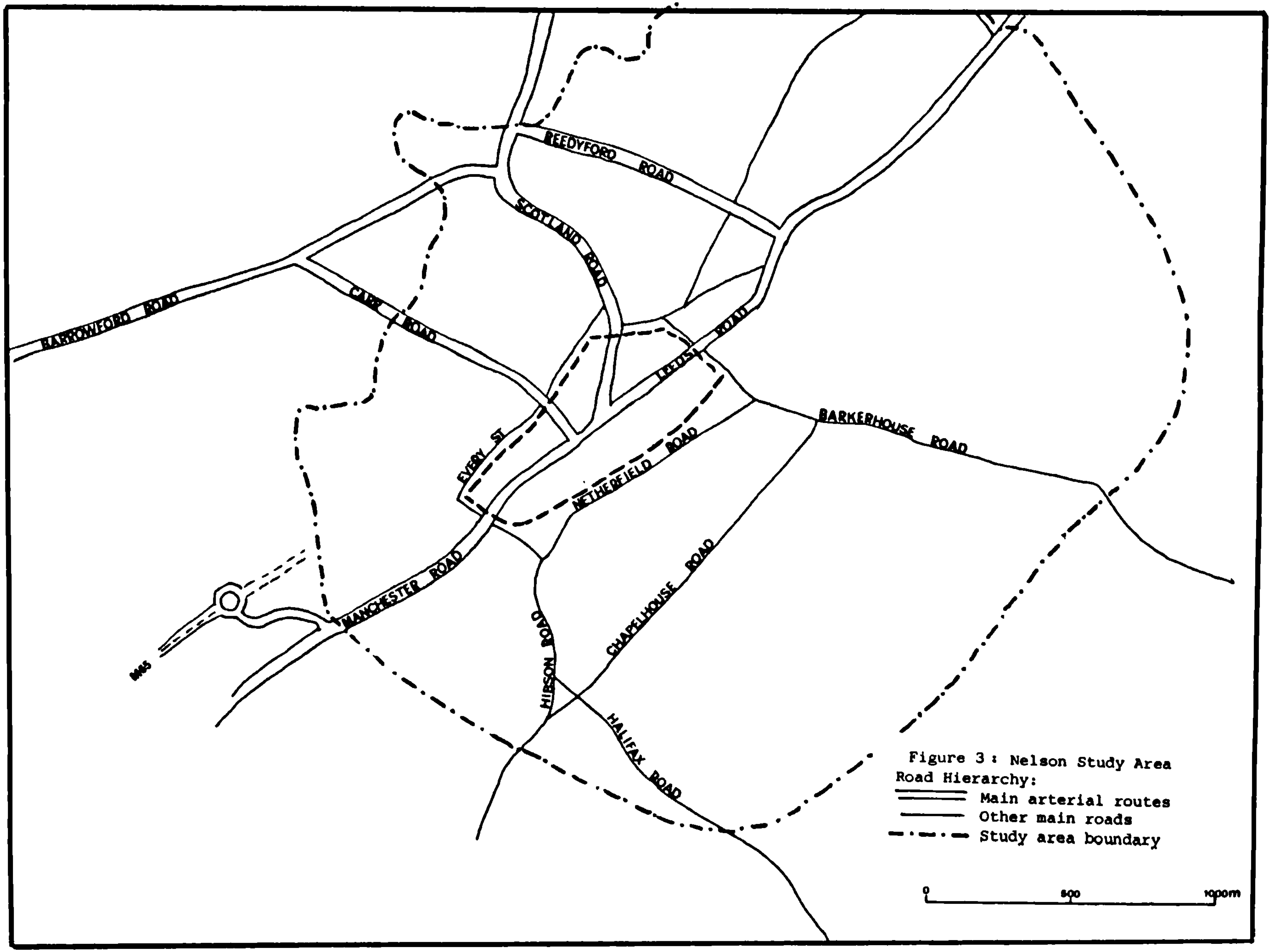


Figure 3 : Nelson Study Area Road Hierarchy:

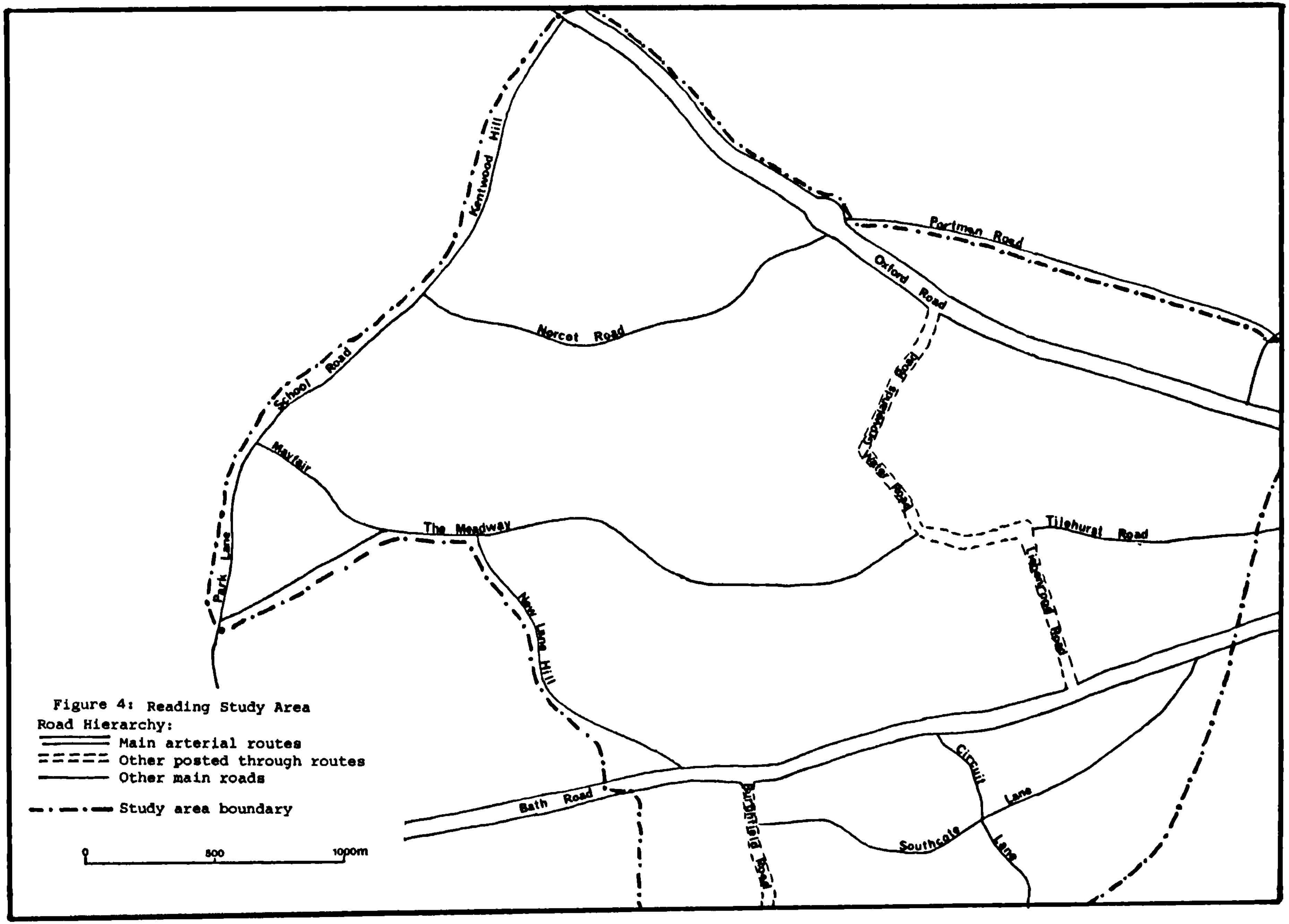


Figure 4: Reading Study Area

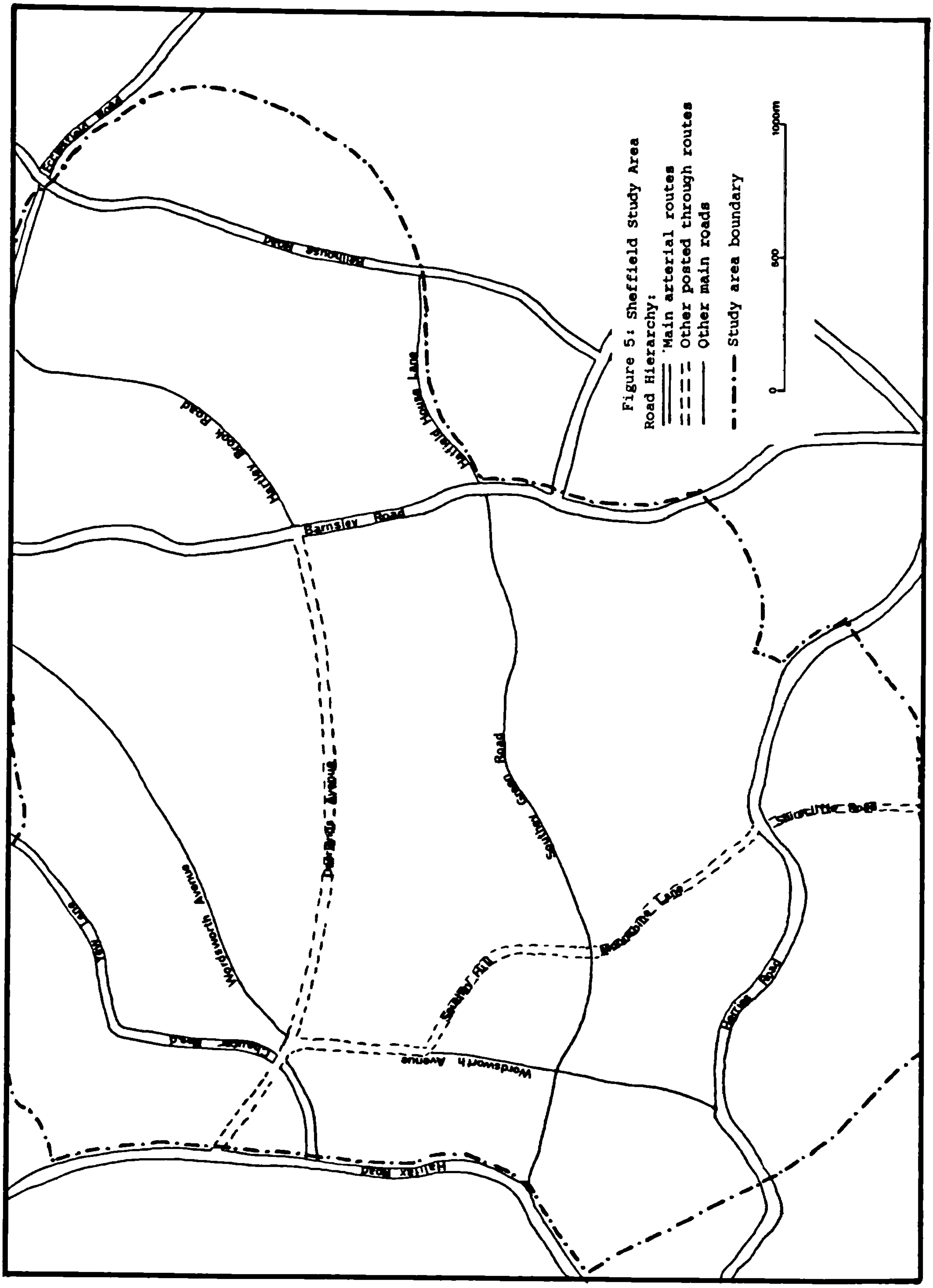


Figure 5: Sheffield Study Area

APPENDIX A.5: Details of GLIM model used in Section 3.5.1.

The accident data referred to in the text were analysed by fitting a log-linear model with a poisson error structure using the interactive computer program GLIM (Baker and Nelder,1978). The form of the model used is shown below:-

$$Y = \exp\{a + b_i + c_j + d_k + (bd)_{ik} + (bc)_{ij} + (cd)_{jk}\}$$

Where:

Y = model estimate of the number of accidents in study area i, to sex j and on type of road k.

i = the study area ($1 =< i =< 5$ for Bradford, Bristol, Nelson, Reading and Sheffield).

j = sex of the child ($1 =< j =< 2$ for males and females).

k = type of road ($1 =< k =< 2$ for main and other sorts of road).

a and the b_i, c_j, d_k, $(bd)_{ik}$, $(bc)_{ij}$ and $(cd)_{jk}$ are fitted parameters.

The statistical significance of the variation between the sex of the child in the proportion of accidents occurring on main roads is that of the interaction term $(cd)_{jk}$. Insertion of this term reduced the deviance (which in this model is distributed like chi-squared under the null hypothesis) by 8.11 using one degree of freedom. The value of the parameter $(cd)_{2,2}$ is -0.4766, and it has a standard error value of 0.1689. This shows that a greater proportion of accidents to girls occur on main roads than accidents to boys, and that the difference is statistically significant ($p<0.005$).

APPENDIX A.10: Distribution of accidents to child pedestrians occurring in darkness in each of the five study areas for the years 1979-1984.

APPENDIX A.13: Definition of severity of injury.

The 'Stats 20' booklet on how to fill in a 'stats 19' form suggests the following definitions for the severity of injuries resultant from road accidents (DTp.,1978):-

Fatal injury This includes only those cases where death occurs in less than 30 days as a result of the accident.

Serious injury Examples of this are:

Fracture

Internal injury

Severe cuts and lacerations

Crushing

Concussion

Severe shock requiring hospital treatment

Detention in hospital as an inpatient, either immediately or later as a result of the injuries

Injuries to casualties who die on or after 30 days as a result of the accident.

Slight injury Examples of this are:

Sprains

Bruises

Cuts judged not to be severe

Slight shock requiring roadside attention.

(persons who are merely shaken and who have no other injury should not be included unless they receive or appear to need medical treatment).

APPENDIX A.14: Distribution of accidents to child pedestrians by severity of injury in each of the five study areas for the years 1979-1984.

APPENDIX A.15: Details of GLIM model used in Section 3.12.

The accident data referred to in the text were analysed by fitting a log-linear model with a Poisson error structure using the interactive computer program GLIM (Baker and Nelder,1978). The form of the model used is shown below:-

$$Y = \exp\{a + b_i + c_j + d_k + (bd)_{ik} + (bc)_{ij} + (cd)_{jk}\}$$

where:

Y = model estimate of the number of accidents in study area i, resulting in severity j and on type of road k.

i = the study area ($1 =< i =< 5$ for Bradford, Bristol, Nelson, Reading and Sheffield).

j = severity of injury ($1 =< j =< 2$ for serious and fatal injuries, and slight injuries).

k = type of road ($1 =< k =< 2$ for main and other sorts of road).

a and the b_i, c_j, d_k, $(bd)_{ik}$, $(bc)_{ij}$ and $(cd)_{jk}$ are fitted parameters.

The statistical significance of the variation between different severities of accidents in the proportion of accidents occurring on main roads is that of the interaction term $(cd)_{jk}$. Insertion of this term reduced the deviance (which in this model is distributed like chi-squared under the null hypothesis) by 4.47 using one degree of freedom. The value of the parameter $(cd)_{2,2}$ is 0.3983 and has a standard error of estimate of 0.1909. This shows that there are a greater proportion of more severe accidents on main roads than slight accidents and that the difference is statistically significant ($p<0.04$).

APPENDIX B.1: Response rates to the questionnaire survey

Table 1: Braaford Schools

Schoolname	No. of forms returned	No. of forms given out	School population	Where completed	School number (see Fig. 1)
FIRST SCHCOLS					
Buttershaw C of E	54	162	162	school	1
Buttershaw	99	128	255	home	2
Cooper Lane	77	153	153	school	3
Hill Top C of E	83	101	101	school	4
Horton Bank Top	55	119	119	school	5
Low Moor C of E	60	100	198	school	6
Reevy Hill	78	160	320	school	7
Wibsey	105	130	383	home	8
Woodside	80	110	218	school	9
St. John the Evangelist	99	140	140	home	10
St. Winifreos C of E	91	125	254	school	11
Total	881	1428	2303		
MIDDLE SCHOOLS					
Buttershaw	104	104	614	school	12
Delf Hill	100	104	426	school	13
Mandale	93	120	246	school	15
Wibsey	108	111	555	school	16
Woodside	95	104	208	school	17
Total	500	543	2049		
SECONDARY SCHOOLS					
Buttershaw Comprehensive	120	170	1579	school	18
TOTAL	1501	2141	5931		

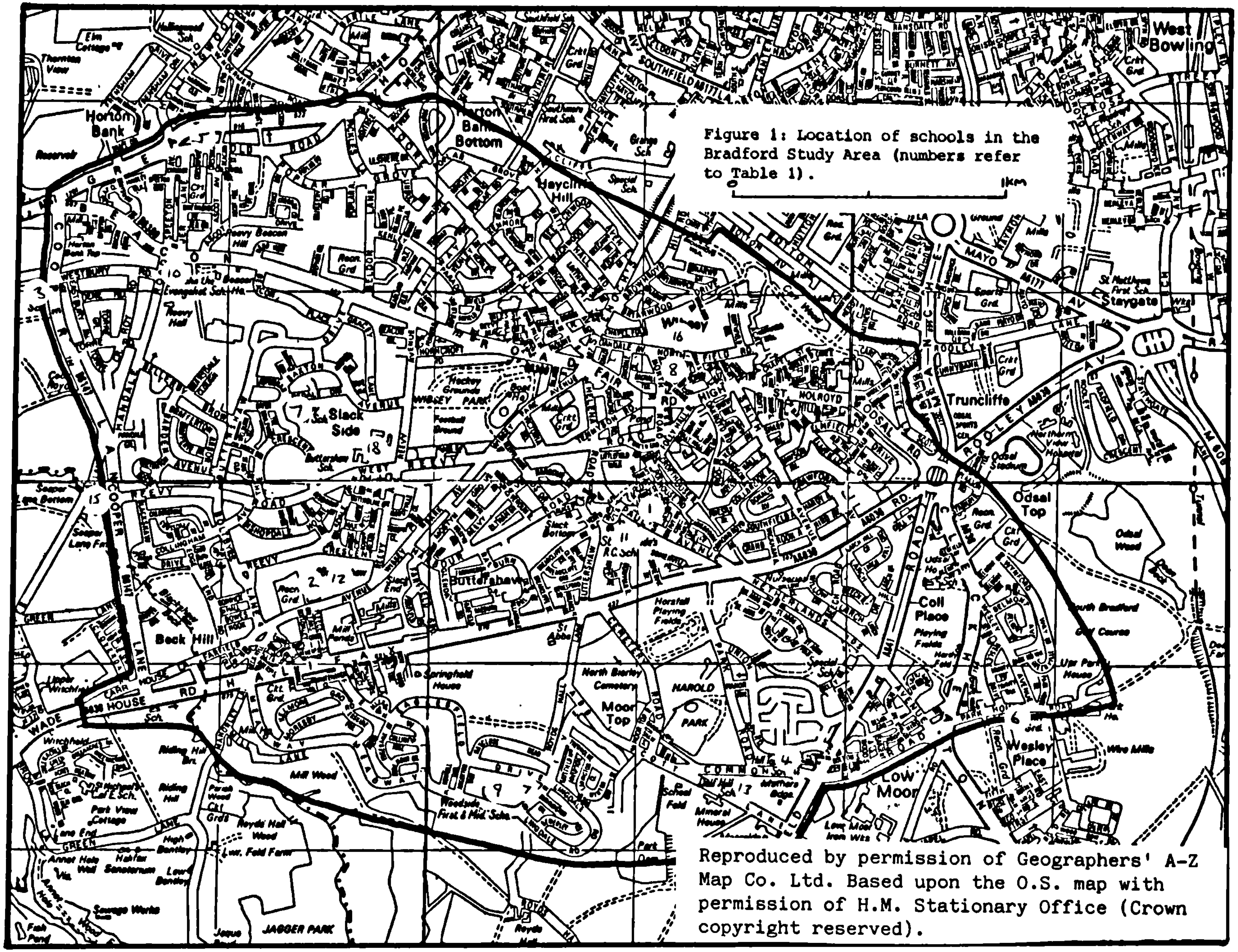


Figure 1: Location of schools in the Bradford Study Area (numbers refer to Table 1).

0 1km

Reproduced by permission of Geographers' A-Z Map Co. Ltd. Based upon the O.S. map with permission of H.M. Stationary Office (Crown copyright reserved).

Table 2: Bristol Schools

Schoolname	No. of forms returned	No. of forms given out	School population	Where completed	School number (see Fig. 2)
INFANTS SCHOOLS					
Blaise	21	74	74	school	20
Brentry	80	88	88	school	21
Charborough Road	37	102	102	school	22
Doncaster Road	27	60	118	school	23
Dunmail	18	70	140	school	24
Embleton	95	146	146	school	25
Fonthill	17	145	145	school	26
Henbury Court	56	83	165	school	27
Horfield	53	90	90	school	28
St. Teresas RC	81	101	101	school	29
Total	485	959	1169		
JUNIOR SCHOOLS					
Blaise	95	99	99	school	30
Brentry	91	117	117	school	31
Charborough Road	101	136	136	school	32
Doncaster Road	115	107	214	school	33
Dunmail	102	94	187	school	34
Embleton	84	100	201	school	35
Fonthill	103	116	232	school	36
Henbury Court	117	114	286	school	37
Horfield	113	121	121	school	38
St. Teresas RC	99	135	135	school	39
Total	1020	1139	1728		
SECONDARY SCHOOLS					
Greenway Boys	104	148	417	school	40
Henbury	140	169	1586	school	41
Monks Park	100	167	1575	school	42
Pen Park Girls	105	131	617	school	43
Total	449	615	4195		
TOTAL	1954	2713	7092		

Table 3: Nelson Schools

Schoolname	No. of forms returned	No. of forms given out	School population	Where completed	School number (see Fig. 3)
INFANTS SCHOOLS					
St Phillips CE	None	None	53	-	44
Bradley CP	None	None	151	-	45
Castercliffe CP	27	101	101	school	46
Holy Saviour RC	17	78	78	home	47
Marsden CP	None	None	72	-	49
St Francis Xavier RC	57	100	100	home	50
St Johns CP	32	90	90	home	51
St Pauls CP	5	103	103	home	52
Walverden CP	56	64	190	school	53
Whitefield CP	48	65	195	school	54
Total	242	601	1133		
JUNIOR SCHOOLS					
St Phillips CE	None	None	71	-	55
Bradley CP	99	100	201	school	56
Castercliffe CP	32	135	135	school	57
Holy Saviour RC	47	103	103	school	58
Lomeshaye CP	47	112	225	school	59
Marsden CP	58	96	287	school	60
St Francis Xavier RC	90	134	134	school	61
St Johns CP	25	120	120	school	62
St Pauls CE	27	138	138	school	63
Walverden CP	57	127	253	school	64
Total	482	1065	1667		
SECONDARY SCHOOLS					
Edge End High	152	177	1040	school	66
Walton High	125	154	904	-	67
Total	277	331	1944		
SPECIAL SCHOOLS					
Hendon Brook	None	None	63	-	69
Townhouse	None	None	54	-	70
Total			117		
TOTAL	1001	1997	4861		

Table 4: Reading schools

Schoolname	No. of forms returned	No. of forms given out	School population	Where completed	School number (see Fig. 4)
INFANTS SCHOOLS					
Battle	54	110	110	school	71
Churchend	20	72	72	school	72
English Martyrs RC	33	63	126	home	73
Grovelands	68	80	159	school	74
Manor	49	69	138	home	75
Norcot	59	65	131	school	77
Park Lane	58	107	213	school	78
Ranikhet	58	65	129	home	79
St Michaels	39	87	87	home	80
Southcote	62	67	134	school	81
Wilson	46	103	103	home	83
Total	546	888	1402		
JUNIOR SCHOOLS					
Battle	35	146	146	school	84
Churchend	72	97	97	school	85
English Martyrs RC	83	84	168	1st years taken home	86
Manor	57	92	183	school	88
Moorlands	65	125	374	school	89
Norcot	107	87	174	school	90
Park Lane	98	95	284	school	91
Ranikhet	82	86	171	school	92
St Michaels	79	115	115	school	93
Southcote	56	89	178	school	94
Upcroft	91	139	277	school	95
Wilson	72	137	137	school	96
Total	897	1292	2304		
SECONDARY SCHOOLS					
Hugh Faringdon RC	111	163	577	school	97
Meadway	86	163	958	school	98
Stoneham Boys	125	165	968	school	99
Westwood Girls	122	160	940	school	100
Presentation College	95	156	550	school	101
Total	539	807	3993		
TOTAL	1982	2987	7699		

Table 5: Sheffield schools

Schoolname	No. of forms returned	No. of forms given out	School population	Where completed	School number (see Fig. 5)
FIRST SCHOOLS					
Beck	44	105	210	home	102
Busk Meadows	34	72	144	home	103
Hartley Brook	22	78	156	home	104
Hatfield House	21	95	190	school	105
Lindsay	45	80	161	school	106
Longley	5	76	153	home	107
Mansel	49	120	239	home	108
Meynell	None	None	221	-	109
Monteney	44	105	209	home	110
Southey Green	74	96	288	home	112
St Thomas More	None	None	42	-	113
Watermead	51	108	216	home	114
Total	389	935	2229		
MIDDLE SCHOOLS					
Beck	119	140	280	1st 2 years taken home	116
Hartley Brook	40	104	208	1st 2 years taken home	118
Hatfield House	105	95	190	school	119
Longley	90	117	234	school	121
Mansel	98	141	282	school	122
Meynell	None	None	295	-	123
Monteney	83	104	312	school	124
Shirecliffe	92	102	203	school	126
Southey Green	91	121	362	school	127
St Thomas More RC	None	None	55	-	128
Total	718	924	2421		
SECONDARY SCHOOLS					
Chaucer	130	123	1448	school	130
Colley	106	111	1041	school	131
Firth Park	73	118	1249	school	132
Herries	83	163	767	school	133
St Peters RC	None	None	375	-	134
Yewlands	135	139	815	school	135
Total	527	654	5695		
SPECIAL SCHOOLS					
Wooley Wood ESN	None	None	59	-	136
TOTAL	1634	2513	10404		

APPENDIX B.2: The primary school questionnaire

SHEFFIELD SCHOOLS: THE ROUTE TO SCHOOL

Hello. I would like to ask you a few questions about yourself and how you travel to school.

Try to write your answers in the correct spaces please.

1. What is todays' date? 20/7/83

2. Please ☑ : are you a boy ☑ girl ☐ ?

3. How old are you? I am 7 years old.

4. What year are you in at school?
I am in the 4th year at school.

5. What road or street do you live in?
BARNSLEY ROAD

6. What is the name of your school?
My school is called HARTLEY BROOK FIRST.

7. How did you come to school this morning?(please ☑).

☐ ☑ ☐ ☐

8. Who did you come to school with this morning?(please ☑)
a. Friends ☐ b. Grown ups ☑ c.On your own ☐

9. About how long did this journey take? It took TEN minutes.

10. How did you get home from school last night?(Please ☑).

☐ ☑ ☐ ☐

11. Who did you go home from school with last night?(Please ☑).
a. Friends ☑ b. Grown ups ☐ c. On your own ☐

12. About how long did this journey take? It took TEN minutes.

Part two: The Route to School

When you left your house this morning:

1. How many roads did you have to cross on foot to get to school?
   I had to cross __5__ roads
(if yo travel by car,bus or bicycle please write down the names of any roads that you cross on foot on yourjourney)

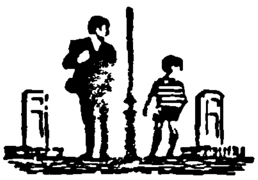
2. If you can remember,write down the names of all the roads you crossed on foot to get to school this morning.

1st road KINNAIRD AVENUE	2nd road KINNAIRD ROAD
3rd road FOLLETT ROAD	4th road KINNAIRD ROAD
5th ad MOLINEUX ROAD	6th road ________
7th road ________	8th road ________
9th road ________	10th road ________
11th road ________	12th road ________

IF YOU CAN'T REMEMBER THEM ALL,TRY TO WRITE DOWN SOME OF THE NAMES OF THE ROADS YOU CROSSED.

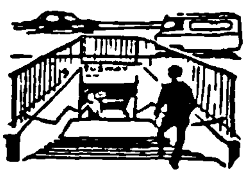
3. Was it raining as you came to school?(please ✓)
   Yes [ ]   No [✓]

4. Did you use any of these to cross a road this morning on foot ? Write in the box below each the number of times you used it.



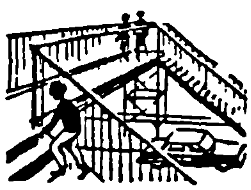
Where there are islands in the middle of the road

[0]



Subways

[0]



Bridges

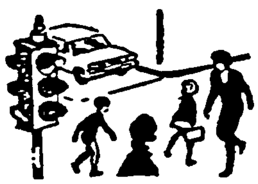
[0]

Where a policeman, school crossing patrol or a traffic warden is controlling the traffic

[0]

Pedestrian Crossings

[0]



Traffic lights/Pelican Crossing

[0]

Part three: The Route Home

When you left school last night:

1. How many roads did you have to cross on foot to get home?
   I had to cross 2 roads.
(If you travel by car, bus or bicycle please write down the names of any roads that you cross on foot on your journey)

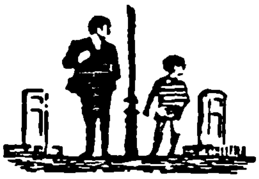
2. If you can remember, write down the names of all the roads you crossed on foot to get home last night.

1st road	MOLINEUX ROAD	2nd road	KINNAIRD AVENUE
3rd road		4th road	
5th road		6th road	
7th road		8th road	
9th road		10th road	
11th road		12th road	

IF YOU CAN'T REMEMBER THEM ALL, TRY TO WRITE DOWN SOME OF THE NAMES OF THE ROADS THAT YOU CROSSED

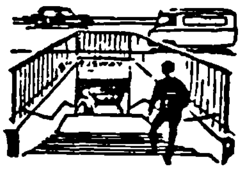
3. Was it raining as you went home from school? (please ☑)
   Yes ☐ No ☑

4. Did you use any of these to cross a road last night, on foot? Write in the box below each the number of times you used it.



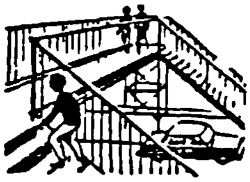
Where there are islands in the middle of the road

[0]



Subways

[0]



Bridges

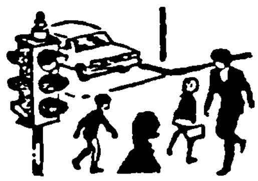
[0]

Where a policeman, school crossing patrol or a traffic warden is controlling the traff

[0]

Pedestrian Crossings

[0]



Traffic lights/Pelican Crossing

[0]

5. On your way home last night did you do any of these things? (please ☑).
a. Go straight home ☑ b. Call at a friends' house ☐ c. Go to the shops ☐
d. Go to the playpark or playing fields ☐ e. Do anything else ☐

Part four: Lunchtime journeys

All children should fill this sheet in. Please try to use the spaces for your answers.

1. Did you stay at school for lunch last lunchtime?(please ✓)

yes ☐ no ☑

IF YOU ANSWERED YES THEN PLEASE GIVE IN THIS QUESTIONNAIRE TO YOUR TEACHER NOW
IF YOU ANSWERED NO,THEN PLEASE ANSWER THE REST OF THE QUESTIONS BEFORE HANDING IN THE QUESTIONNAIRE.

2. If you went outside the school last lunchtime where did you go?(please ✓)

a. I went home ☑ b. I went to the shops ☐

c. I went to a friends' house ☐ d. I went somewhere else ☐

3. How many roads did you cross while you were outside the school last lunchtime?
I crossed 7 roads.

4. What is the name of the road that your answer to question two is in?
It is in BARNSLEY ROAD

5. Was it raining during this lunchtime?(please ✓)
Yes ☐ No ☑

6. Who did you go outside school with last lunchtime? (please ✓).

a. Friends ☑ b. Grown ups ☐ c. On your own ☐

THANK YOU FOR FILLING IN THIS QUESTIONNAIRE. PLEASE HAND IT IN TO YOUR TEACHER NOW.

APPENDIX B.3: The secondary school questionnaire

BRADFORD SCHOOLS: The Route to School

All pupils should fill in this questionnaire Try to use the spaces provided for your answers.

1. Are you: a. a boy ☐ b. a girl ☑ ? (please ✓).

2. What is the name of your school? Buttershaw Upper

3. How old are you? 14 years.

4. Which year are you in at school? (e g 1st, 2nd etc) 3rd year.

5. What is today's date (only fill in the date on which you actually fill in this form)? 23-9-83

6. What is your address? (name of road only please) Park Square

7. How did you come to school this morning? (please ✓).

   a. I walked all the way ☑ b. I came by public bus ☐
   c. I came by school bus ☐ d. I came by private car or taxi ☐
   e. I came by bicycle ☐ f. Other ☐

8. Who did you come to school with this morning? (Please ✓).

   a. I travelled alone ☑ b. Mother ☐ c Father ☐ d Friend ☐
   e. Older brother or sister ☐ f. Younger brother or sister ☐ g. Neighbour ☐
   h. Other ☐

9. About how long did this journey take? It took 2 minutes.

10. How did you go home from school last night? (please ✓).

   a. I walked all the way ☑ b. I travelled by public bus. ☐
   c. I travelled by school bus ☐ d. I came by private car or taxi ☐
   e I came by bicycle ☐ f. Other ☐

11. Who did you go home with last night? (please ✓).

   a. I travelled alone ☑ b. Mother ☐ c Father ☐ d Friend ☐
   e. Older brother or sister ☐ f. Younger brother or sister ☐ g Neighbour ☐
   h Other ☐

12. About how long did this journey take? It took 2 minutes

13. If you travel to school by bus please write the route number down here __________

14. If you travel home by bus please write the route number down here __________

Part two: the Route to School

All pupils should fill in this section. Please try to use the spaces provided for your answers.

1. Fill in the following table about how you came to school this morning. to do this you will need to write the name of each road you crossed on foot in the first column. In the second column pick the method by which you crossed the road (e g. 'pelican' or 'none of these') and put a ring around that word i.e. zebra. Finally in the last column put a ring around the correct answer for each road.

NAME OF ROAD CROSSED	DID YOU CROSS BY ANY OF THE FOLLOWING METHODS? PUT A RING AROUND THE CORRECT ONE	DID YOU CROSS WITHIN 20 METRES OF A JUNCTION?
1st Reavy Avenue	Zebra Pelican Footbridge Subway Crossing patrol None of these	~~Yes~~/No
2nd	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
3rd	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
4th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
5th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
6th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
7th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
8th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
9th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
10th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
11th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
12th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No

IF YOU CROSS MORE ROADS THAN THIS ON YOUR JOURNEY THEN PLEASE COLLECT ANOTHER PIECE OF PAPER FROM YOUR TEACHER AND CONTINUE ON THAT.

2. Was it raining as you came to school? (Please ☑)

Yes ☐ No ☑

Part three: The Route Home

All pupils should fill in this section, Please try to use the spaces provided for your answers.

1. Fill in the following table about how you went home from school last night To do this you will need to write the name of each road you crossed on foot in the first column. In the second column pick the method by which you crossed the road (e.g. 'pelican' or none of these) and put a ring around that word i.e. Zebra Finally in the last column put a ring around the correct answer for each road.

NAME OF ROAD CROSSED	DID YOU CROSS BY ANY OF THE FOLLOWING METHODS? PUT A RING AROUND THE CORRECT ONE	DID YOU CROSS WITHIN 20 METRES OF A JUNCTION?
1st Reavy Avenue	Zebra Pelican Footbridge Subway Crossing patrol None of these	~~Yes~~/No
2nd	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
3rd	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
4th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
5th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
6th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
7th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
8th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
9th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
10th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
11th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
12th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No

IF YOU CROSS MORE ROADS THAN THIS ON YOUR JOURNEY THEN PLEASE COLLECT ANOTHER PIECE OF PAPER FROM YOUR TEACHER AND CONTINUE ON THAT.

2. Was it raining on your way home last night? (Please ☑)

Yes ☐ No ☑

3. On your way home last night did you do any of these things? (please ☑).

a Go straight home ☑ b. Call at a friends' house ☐ c. go to the shops ☐

d Go to the playpark or playing fields ☐ e. Do anything else ☐

Part four: Lunchtime journeys

NB You should only fill this section in if you made a journey outside the school grounds on foot last lunchtime. Try to use the spaces provided for your answers.

1. Where did you go outside the school last lunchtime? (please give the name of the place and the street it is in).

____

2. Fill in the following table about the roads you walked along while outside the school. To do this you will need to write the name of each road you crossed on foot in the first column. In the second column pick the method by which you crossed the road (e.g. 'pelican' or 'none of these') and put a ring around that word i.e Zebra. Finally in the last column put a ring around the correct answer for each road

NAME OF ROAD CROSSED	DID YOU CROSS BY ANY OF THE FOLLOWING METHODS? PUT A RING AROUND THE CORRECT ONE	DID YOU CROSS WITHIN 20 METRES OF A JUNCTION?
1st	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
2nd	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
3rd	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
4th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
5th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
6th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
7th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
8th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
9th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No
10th	Zebra Pelican Footbridge Subway Crossing patrol None of these	Yes/No

IF YOU CROSS MORE ROADS THAN THIS ON YOUR JOURNEY THEN PLEASE COLLECT ANOTHER PIECE OF PAPER FROM YOUR TEACHER AND CONTINUE ON THAT.

3. Was it raining during this lunchtime? (Please ☑)

Yes ☐ No ☐

4. Who did you make this journey with? (please ☑)

a. I travelled alone ☐ b. Mother ☐ c Father ☐ d. Friend ☐

e. Older brother or sister ☐ f. Younger brother or sister ☐ g. Neighbour ☐

h. Other ☐

APPENDIX B.4: The primary school questionnaire (teachers notes)

The following notes have been provided to try to ensure as much as possible, consistency of answers. Below are some of the main areas where doubt about the form of an answer could arise (these have all arisen in past studies) and it would be appreciated if you, the teacher, could use these notes to attempt to standardise your pupils answers for these particular questions, and also as an aid to solving any difficulties that may arise in the completion of these questionnaires.

General points on the questionnaire

a. Could teachers please stress the importance of this questionnaire for research purposes and ask that pupils fill in their answers as accurately as possible.

b. It has been shown in previous studies that some pupils treat a dual carriageway as two roads rather than one when answering the questions. For the purposes of this questionnaire they should be treated as one road please.

Points relating to specific questions

Page 1

Question 1: Children should fill in the date on which they actually complete these forms. All of the answers following this should relate to journeys that the child made home from school last night (the questionaire should not be filled in on a Monday or the day after a holiday), to school this morning and during the last lunch period (i.e. today or yesterday depending on whether or not the questionnaire is completed in the morning or the afternoon).

Question 7: If the child comes to school by more than one method then please ask them to enter more than one tick.

Question 8: If the child comes to school with both friends and grown ups then they should tick both boxes.

Question 10: see question 7.

Question 11: see question 8.

Page 2

Questions 1 and 2: Any help that can be given to the children on these questions will be much appreciated, however their answers should not be influenced , nor fully completed for them.

Maps of the local area will be provided which might be of help in naming roads crossed.
Children should be asked to make sure that the number of roads in their answer to question 1 is the same as the number of names filled in on their answer to question 2 (only if all of the road names on question two cannot be ascertained should the two answers differ).

Question 4: Children might need to be reminded that they should not tick the boxes here, but write in them the number of times that each facility is used e.g. 0, 1, or 2 etc.

Page 3

Questions 1, 2, 3, and 4: These should be filled in as for Page 4.

Question 5: Those filling in part 'a' as their answer should not tick any other boxes. Apart from this more than one box can be ticked.

Page 4

Question 1: Staying for lunch means that the child did not go outside the school that lunchtime. It should be stressed that all children should fill in at least part of this page.

Question 2: If the child did more than one thing at lunchtime then they should tick all the relevant boxes.

Question 3: When the children write in the number of roads they crossed that lunchtime please remind them that if they went home, for instance, then they will have crossed something like twice as many roads as they did that morning as they will also have had to come back to school after going home.

THANK YOU FOR ANY HELP THAT YOU GIVE TOWARDS THE SUCCESSFUL COMPLETION OF THIS QUESTIONNAIRE

APPENDIX B.5: The secondary school questionnaire (teachers notes)

The following notes have been provided to try to ensure as far as possible, consistency of answers. Below are some of the main areas where doubt about the form of an answer could arise (these have all come up in past studies) and it would be appreciated if you, the teacher, could use these notes to attempt to standardise your pupils answers for these particular questions, and also as an aid to solving any difficulties that may arise in the completion of these questionnaires.

General points on the questionnaire

a. Could teachers please stress the importance of this questionnaire for research purposes and ask that pupils fill in their answers as accurately as possible.

b. A second general point that came to light in previous studies is that some pupils treat a dual carriageway as two roads rather than one when answering the questions. For the purposes of this questionnaire they should be treated as one road please.

Points relating to specific questions:

Page 1

Question 7: If a pupil comes to school by more than one method then please ask them to tick all the relevant boxes.

Question 8: If a pupil comes to school with more than one person or category then please could they tick more than one box.

Questions 10 and 11: Do the same for these as for questions 7 and 8.

Questions 13 and 14: If the pupil comes by school bus could they fill the route number in here as well. Also could only the numbers of the bus/buses used on the particular journeys in question be filled in, and not (as has been the case in the past all of the bus numbers that it is possible for a child to take.

<u>Page 3</u>

Question 3: Please ask the child to tick more than one box if more than one activity was carried out.

<u>Page 4</u>

Question 1: Please remind all pupils to fill this question in. If they go to more than one place during lunchtime could they list them all.

Question 2: Please remind your pupils that there are both there and back components to lunchtime journeys.

Question 4: If the pupil travelled with more than one person please enter more than one tick.

THANK YOU FOR ANY HELP THAT YOU GIVE TOWARDS THE SUCCESSFUL COMPLETION OF THIS QUESTIONNAIRE

APPENDIX B.6: Form of letter sent home with some children

Dear Parent

Road Safety Research

The Transport Studies Group at University College London are, with the cooperation of the Local Authorities, conducting research into road accidents to children in this part of Sheffield.

As part of this project your child will be asked to take home and complete a questionnaire concerning his/her journey to and from school. The information asked for will not be identifiable to any one child and will be used only for research purposes.

If you are willing to let your child give this information would you please help him/her to fill in the attached questionnaire as fully as possible and return it tomorrow morning to his/her class teacher.

May I thank you for your help in this important child safety study.

Yours faithfully

APPENDIX B.7: Variables coded for the surveys of children's use of the roads on journeys to and from school

Variable name	Meaning of variable	Column numbers	Possible values	Meaning of values
Sex	Sex of child	1	M or F	Male or female
Age	Age of child	2-3	4-17	Age in years
Yeartype	Type of school and yeargroup	4-5	11-99 (not inc)	11-13=1st to 3rd year infants, 21-25=1st to 5th year first school, 31-34=1st to 4th year juniors, 41-44=1st to 4th year middle, 51-55=1st to 5th year secondary, 99=unknown
Date	Date on which the questionnaire was completed	6-13	In the form dd/mm/yy	
Ed	Enumeration district in which the child lives	14-17	In the form AA01	
Modein	Mode of travel on the way to school	18-19	10-70 (not inc)	10=walk,20=public bus,30=school bus, 40=car,50=bicycle, 60=other, 70=unknown All combinations of these modes are also coded e.g. 22=public bus and car

Accomin	Accompaniment on the way to school	20-22	100-900 (not inc)	100=alone, 200=mother, 300=father,400=pal 500=older brother or sister, 600=young brother or sister, 700=Neighbour, 800=other, 900=unknown Combinations of these people were also coded e.g. 211=mother, father and pal
Timein	Time taken on the way to school	21-24	1-99	Time in minutes, 99=unknown
Modeout	Mode of travel on the way home	25-26		See modein
Accomout	Accompaniment on the way home	27-29		See accomin
Timeout	Time taken on the way home	30-31		See timein
Schname	Name of school	32-34	1-135 (not inc)	1-19=schools in Bradford, 20-43=schools in Bristol, 44-70=schools in Nelson, 71-101=schools in Reading, 102-135=schools in Sheffield
Town	Name of study area	35	1-5	Bradford,Bristol, Nelson,Reading, Sheffield
Numin	Number of roads crossed on the way to school	36-37	1-25,99	99=unknown
Distin	Distance travelled on the way to school	38-41		Distance in kms 9.99=unknown

Pcin	Number of crossing facilities used on the way to school	42	1-9	
Islin	Number of traffic islands used on the way to school	43	1-9	
Subin	Number of subways used on the way to school	44	1-9	
Briain	Number of bridges crossed on the way to school	45	1-9	
Scpin	Number of school crossing patrols used on the way to school	46	1-9	
Zebin	Number of zebra crossings used on the way to school	47	1-9	
Pelin	Number of pelican crossings used on the way to school	48	1-9	
Rainin	Weather on the way to school	49	0-2	Not raining, raining, or unknown
Numout	Number of roads crossed on the way home	50-51		See numin
Distout	Distance travelled on the way home	52-55		See distin
Pcout	Number of crossing facilities used on the way home	56	1-9	
Islout	Number of traffic islands used on the way home	57	1-9	
Subout	Number of subways used on the way home	58	1-9	

Bridout	Number of bridges crossed on the way home	59	1-9	
Scpout	Number of school crossing patrols used on the way home	60	1-9	
Zebout	Number of zebra crossings used on the way home	61	1-9	
Pelout	Number of pelican crossings used on the way home	62	1-9	
Rainout	Weather on the way home	63	0-2	See rainin
Wayhome	Activity on the way home	64-65	10-60 (non inc)	10=straight home, 20=to a pals house,30=shops, 40=park,50=other, 60=unknown, Other logical combinations of these are also coded e.g. 21= pals house and shops
Dinstay	Whether or not stayed to school lunch	66	0-1	Went home or stayed at school
Wheredin	Where the child went at lunchtime	67-68	10-60 (not inc)	10=home,20=pals or relatives house,30=shops, 40=elsewhere, 50=stayed at school, 60=unknown No combinations of these were recorded
Numdin	Number of roads crossed at lunchtime	69-70		See numin

Rainoin	weather at lunchtime	71		See rainin
Accomdin	Accompaniment at lunchtime	72-74		See accomin
Rione-Ritfive	Variables containing the number of each road crossed on the way to school. All 25 (RIOne=Road In One,RITFive= Road In Twenty Five) variables are completed for each child, though for instance, if only ten roads are crossed,then variables RIEleven to RITFive would be classed as '000'	1-75	000-999	000 means no road crossed,999 means road location unknown. The remainder of the numbers relate to large scale maps of the areas, each number representing a crossing point
Roone-Rotfive	See above,but on the way home	1-75		
Quality	Quality of the responses	76	0-3	0=excellent, 1=good,2=workable, 3=poor

APPENDIX C.1: Variables coded for the surveys of children's use of the roads for purposes other than going to and from school

Variable name	Meaning of variable	Column numbers	Possible values	Meaning of values
Day	Day of survey	1	1-5	Monday to Friday
Time	Time of day of survey	2	1-5	0900-10.30,10.45-12.15,14.00-15.30, 16.45-18.15,18.30-20.00
Section	The section of road	3	1-5	Section 1-5
Link	Exact position within section	4-6	1-139 in Bristol, 1-361 in Nelson	
Position	Location in road	7	1-4	On pavement,in the road,elsewhere in the vicinity of the pavement(not in the road),other
Sex	Sex of child	8	1-2	Male or female
Age	Age of child	9	1-3	Pre-school,primary school, or secondary school
Adultacc	Accompaniment by adults	10	1-4	1,2,3, or more than 3 adults
Olderacc	Accompaniment by older children	11	1-9	1,2,3,4,5,6,7,8,or more than 8 older children
Otheracc	Accompaniment by contemporaries and younger children	12	1-9	1,2,3,4,5,6,7,8,or more than 8

Activity		13-14	1-99	1=running, 2=walking, 3=standing, 4=crossing, 5=sitting, 6=playing, 7=on school journey, 8=errand, 9=cycling, 10=cycling with BMX bike, 11=other, 12-99(not inclusive)=all logical possible combinations of these activities e.g. 'walking playing', or 'sitting playing'
Weather	Weather at the time of the survey	15	0-2	Dry and sunny, overcast or rain
Mobssobs	Moving observer or standing observer observation	16	0-1	Moving observer, standing observer
Secttime	Time taken to walk along each section	17-21		Time in the form xx.yy(minutes and seconds)